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Soil Survey

The Salt Lake Area Utah

By
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United States Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Plant Industry, Soils and Agricultural Engineering
In cooperation with the
Utah Agricultural Experiment Station

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HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS provide a foundation for all land use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part. Ordinarily he will be able to obtain the information he needs without reading the whole. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers of three general groups: (1) Those interested in the area as a whole; (2) those interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. Attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, resettlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) Description of the Area Surveyed, in which location and extent, physiography, relief, and drainage, climate, vegetation, history and population, rural culture, transportation and markets, and industry and business are discussed; (2) Agricultural History and Statistics, in which a brief history and the present status of the agriculture are described; (3) Land Uses and Farming Methods, in which the present uses of the soils are described, their management requirements discussed, and suggestions made for improvement.

Readers interested chiefly in specific areas—as some particular locality, farm, or field—include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm loan agencies. These readers should (1) locate on the map the tract with which concerned; (2) identify the soils on the tract by locating in the legend on the margin of the map the symbols and colors that represent them; and (3) locate in the table of contents in the section on Soils and Crops the page where each type is described in detail and information given as to its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Productivity Rating and Soil-Use Grouping and on Land Uses and Farming Methods.

Students and teachers of soil science and allied subjects—including crop production, forestry, animal husbandry, economics, rural sociology, geography, and geology—will find their special interest in the section on Morphology and Genesis of Soils. They will also find useful information in the section on Soils and Crops, in which are presented the general scheme of classification of the soils of the area and a detailed discussion of each type. For those not already familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions. Teachers of other subjects will find the sections on Description of the Area Surveyed, Agricultural History and Statistics, the first part of the section on Soils and Crops, and Irrigation, Drainage, and Alkali of particular value in determining the relations between their special subjects and the soils of the area.

This publication on the soil survey of the Salt Lake area, Utah, is a cooperative contribution from the—

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SOIL SURVEY OF THE SALT LAKE AREA, UTAH

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United States Department of Agriculture in cooperation with the Utah Agricultural Experiment Station

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[1] The field work for this survey was done while the Division was a part of the Bureau of Chemistry and Soils.

AGRICULTURALLY the Salt Lake area, Utah, is considerably diversified. Under irrigation the principal crops are alfalfa, small grains, corn, potatoes, and sugar beets. The increasing importance of fruit and vegetable production has closely paralleled the growth of Salt Lake City. Livestock production began with the introduction of agriculture on the virgin areas of the valley. Cattle and sheep were first grazed, but the industry soon spread to the mountains and deserts. Dairy farming has expanded with the increased need for fluid milk accompanying the growth of Salt Lake City. Dry farming also is undertaken to a large extent for the production of winter wheat on the west side of the valley and above the upper irrigation canal. In order that the lands might be used most efficiently for profitable agriculture a soil survey of the area was begun in 1936 by the United States Department of Agriculture in cooperation with the Utah Agricultural Experiment Station. The results, which may be briefly summarized as follows, are presented in this report.

SUMMARY

The Salt Lake area is in the north-central part of Utah. Salt Lake City is near the northeastern boundary. The valley of the Jordan River, which comprises most of the area surveyed, lies between the Wasatch Range on the east and the Oquirrh Mountains and the Great Salt Lake on the west and northwest.

There is a considerable range in elevation from the valley to the mountains. The level of the Great Salt Lake at the time this survey was made was approximately 4,200 feet. The highest elevation of the valley land is approximately 5,200 feet. The Wasatch Range east of the area reaches an elevation of about 11,000 feet.

The Salt Lake area has four general topographic divisions: (1) The gently sloping higher alluvial fans and lake terraces, which make up most of the southern and eastern parts of the area; (2) the bottom lands and adjoining low terraces and alluvial fans along the Jordan River and tributaries; (3) the low, nearly flat, lake plain, which makes up the northwestern part of the area; and (4) the mountains, bordering the area on east and west.

The climate is semiarid, with well-defined seasons and considerable daily fluctuations in temperature. The average annual precipitation at Salt Lake City is 16.19 inches. June, July, and August are the driest months of the year, and March, April, and May are the wettest. In the winter a large portion of the precipitation is in the form of snow.

There is some variation of climate within the valley. The territory adjacent to the Wasatch Range is somewhat warmer and has a trifle more precipitation than the central part of the valley. Salt Lake City has an average frost-free season of 187 days, whereas Midvale, near the center of the valley, has a frost-free season of only 133 days.

Diversion of water from City Creek for irrigation in 1847 was one of the first undertakings of the Mormon pioneers. The practice of irrigation spread rapidly. In 1848, 5,153 acres were put under irrigation; by 1899 a total of 54,598 acres was irrigated; by 1909, 82,710 acres; and by 1919, 102,051 acres. In 1929 the area under irrigation was 93,633 acres, and in 1939 it was 72,668 acres. The decline is attributed by the United States Reclamation Service to drought and a lowering of the water supply.

The soils of the area, like most soils of other arid regions, are rich in mineral plant nutrients, and in many places, even when the soil is provided with good drainage, the more soluble mineral salts, usually called alkali, are accumulated, especially in the subsoil. The soils are generally higher in nitrogen and organic matter than those of the more arid parts of the West and Southwest. The upper layers of a number of the important mature soils, which constitute a considerable part of the total area, have been leached of calcium carbonate and gypsum, and deposition of these constituents has taken place in the subsoil.

The soils of the area are placed in five groups, on the basis of topographic position, drainage, and soil characteristics, as follows: (1) Well-drained soils of the terraces and alluvial fans, (2) well-drained and excessively drained soils of the higher alluvial fans, (3) imperfectly and poorly drained soils of the bottom lands and of the lower and flatter areas on the terraces and alluvial fans, (4) poorly drained salty soils of the lake plain, and (5) miscellaneous soils and land types, largely nonarable. These large groups are made up of subgroups differing from one another in internal soil characteristics.

The well-drained soils of the alluvial fans and terraces have developed from medium to fine-textured materials, have good moisture-holding capacity, and are for the most part rather highly productive and well suited to the production of a rather wide variety of crops under irrigation and to a less extent to the production of wheat under dry farming. The group contains most of the soils of the Welby, Taylorsville, Parleys, Avon, Red Rock, Draper, and St. Marys series, and the well-drained phase of Decker loam. The Welby, Taylorsville, Parleys, Avon, and Decker soils are mature (zonal) soils with distinct subsoil layers of accumulated lime; whereas the Red Rock, Draper, and St. Marys soils are immature (azonal) soils with little or no distinct accumulation of lime in the subsoils.

The well-drained and excessively drained soils of the higher alluvial fans include the Bingham, Churchill, Knutsen, and Wasatch soils. They are developed largely from coarse sandy and gravelly materials, or both, have medium to low moisture-holding capacity, and are generally less productive and less well suited to production of crops than the soils of the first group. The Bingham soils are thin soils with limy subsoils overlying porous gravel beds; the Churchill soils are similar to the Bingham but have a lime hardpan or tufa above the gravel; the Knutsen soils are similar to the Bingham but generally shallower and contain little or no lime in the subsoils; the Wasatch soils

are sandy soils over loose sand and gravel and contain little or no lime. The Bingham soils are fairly well suited to dry-farmed wheat; the Churchill soils, to general farming under irrigation; and some of the better Knutsen and Wasatch soils are well adapted to the production of fruit.

The imperfectly and poorly drained soils of the bottom lands and of the lower and flatter areas on the terraces and alluvial fans include the soils of the Logan, Gooch, and Decker series and the poorly drained phases of the Welby, Taylorsville, Red Rock, Wasatch, Knutsen, and Draper soils. These soils are used largely for pasture, although many areas that are imperfectly rather than poorly drained are used for the production of vegetables and the common crops.

The poorly drained salty soils of the lake plain include the Airport, Terminal, and Saltair soils. They are very poorly suited to the production of crops and have low value as range for livestock.

The miscellaneous soils and land types, largely nonarable, have one or more undesirable characteristics that disqualify them for the production of crops.

The total extent of imperfectly and poorly drained soils is slightly more than one-third of the total area surveyed. About 45 percent of the land that is sufficiently level and otherwise suitable for cultivation is imperfectly or poorly drained.

Most of the poorly drained lands are affected with harmful concentrations of soluble salts (alkali), and in about 60 percent of the areas affected the concentrations are excessive.

The source of the salts is probably the waters of the Great Salt Lake, which within the memory of the older inhabitants has covered much of the low-lying lands. The salts are composed largely of sodium chloride, with smaller quantities of sodium sulfate.

At the present time the net irrigated acreage within the Salt Lake area is probably more than 60,000 acres. The sources of the irrigation water are the Jordan and Provo Rivers and a number of small streams that issue from the Wasatch Range and the Oquirrh Mountains. Utah Lake is used as a storage reservoir, and water from this lake flows through the Jordan River to the Great Salt Lake.

DESCRIPTION OF THE AREA SURVEYED

LOCATION AND EXTENT

The Salt Lake area is in north-central Utah (fig. 1). It is an irregular strip of territory extending across the central part of Salt Lake County in a north-south direction. It includes somewhat more than one-half of the county—the valley part and practically all of the arable land. The total area is 447 square miles, or 286,080 acres.

This area includes a small area covered by one of the earliest soil surveys made in the United States (*6*).[2]

Salt Lake City, the capital of Utah, is near the northeastern bound ary of the area. The Great Salt Lake, approximately 15 miles west of the business section of Salt Lake City, forms a part of the northern and western boundaries of the area.

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[2] Italic numbers in parentheses refer to Literature Cited, p. 80.

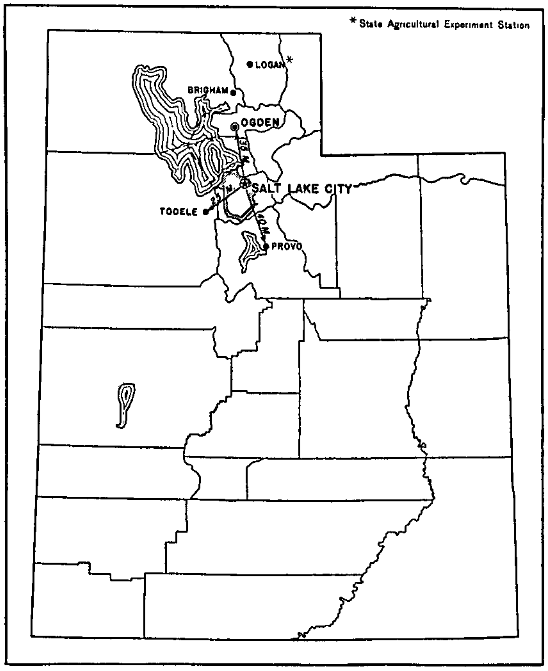


FIGURE 1.—Location of the Salt Lake area in Utah.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

The Salt Lake area lies at the western foot of the Wasatch Range, on the eastern edge of the basin of prehistoric Lake Bonneville (7)—slightly north of the center. Lake Bonneville at a comparatively late geologic period covered an area of slightly less than 20,000 square miles in the eastern part of the Great Basin, which in turn makes up a part of the Basin and Range geologic province.[3] The Great Salt Lake, a shrunken remnant of old Lake Bonneville, occupies the lowest part of the basin.

The area consists of a covelike extension of the Lake Bonneville basin, including the lower and greater part of the valley of the Jordan River. This valley lies between the lofty Wasatch Range on the east, the Oquirrh Mountains on the west, and the Great Salt Lake on the northwest. The Wasatch Range extends far to the north and south of the area, whereas the Oquirrh Mountains terminate at the southern end of the Great Salt Lake. The Wasatch Range has been described as consisting of a "series of bights and salients." Two salients or spurs extend westward from the axis of the range into the Jordan Valley—one, the City Creek Spur, just north of Salt Lake City, and the other, the Traverse Mountains, at the south end of the area. Between these two spurs a bight or cove about 25 miles long from north to south forms the eastern edge of the valley. The Traverse Mountains, which in their central part

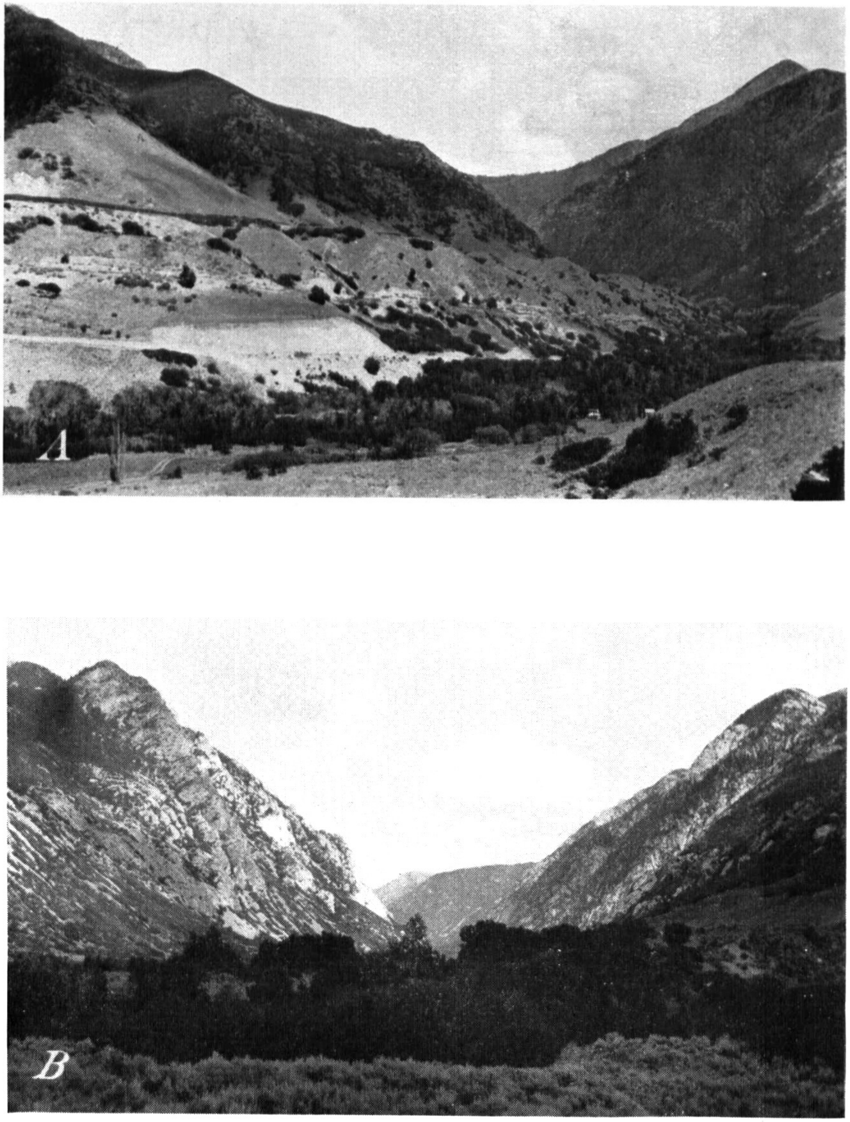
[3] FENNEMAN, N. M. PHYSICAL DIVISIONS OF THE UNITED STATES. U. S. Geol. Survey Map. 1930.

are merely a range of low hills, form a connection between the Wasatch Range and the Oquirrh Mountains.

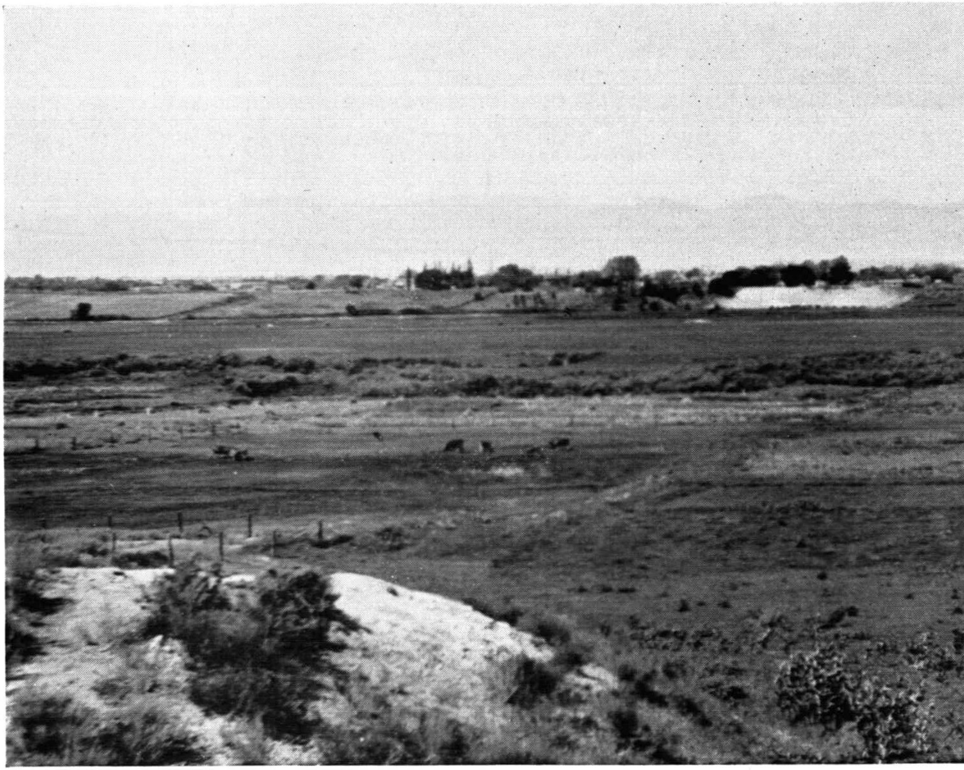
The Jordan River, which forms the outlet of Utah Lake in Utah County, flows northward in a meandering course until it reaches the range of hills near the southern boundary of Salt Lake County. Here it has cut a deep channel, known locally as the Jordan Narrows. Just north of the county line the river emerges from the hills and follows a generally northward though meandering course for about 20 miles, then turns somewhat to the northwest to flow into the Great Salt Lake. In Salt Lake County the principal tributaries of the Jordan River are Little Cottonwood, Big Cottonwood, Mill, Parleys, Emigration, and City Creeks, all issuing from the Wasatch Range. Dry Cottonwood and Red Butte Creeks are smaller streams issuing from the Wasatch; and Butterfield and Bingham Creeks, heading in the Oquirrh Mountains, are now practically dry washes. All these creeks enter the Jordan River Valley through narrow, rugged canyons.

The Great Salt Lake, which at present has no outlet, has an area of about 2,000 square miles and an average depth of only 15 feet. During the last 100 years the volume of the lake has undergone considerable variation, and the low stages may be attributed, in part at least, to diversion of streams within the basin for irrigation. According to Gilbert (*7*), however, the lake in past centuries has undergone several periods of filling followed by periods of desiccation, with intermittent periods of relative balance. The periods of relative equilibrium between filling and desiccation have left a record on the surrounding hills in the form of old lake-shore lines (pl. 1, *A*). The highest shore line recorded, which, according to Gilbert (*7*), is slightly less than 5,200 feet above sea level, is known as the Bonneville shore line or the Bonneville level. This high stage of the lake is thought to be coincident with the Wisconsin glacial epoch, since well-preserved terminal moraines occur near the mouths of Big Cottonwood and Little Cottonwood Canyons, both of which are well-defined glacial canyons (pl. 1, *B*). After remaining near this level for a time sufficient to imprint its shore line on the landscape, the lake finally filled and overflowed at Red Rock Pass, its northernmost point, draining through Cache Valley into the Snake River to the north. Within a comparatively short time the outlet was eroded to a point 375 feet below the elevation of the first outflow. At this point the stream-cutting met a resistant stratum, and the overflow was held in check for a comparatively long time.

It was while the lake stood at this level, just under 4,800 feet, that many of the more important land features of the Jordan River Valley were formed. Streams entering the valley from the Wasatch Range on the east and from the Oquirrh Mountains on the west built large alluvial fans and deltas, many of which ultimately coalesced, forming what is now the extensive gently sloping fans and terraces that make up much of the southern and eastern parts of the valley. With minor exceptions the irrigated area of the valley is below the 4,800-foot level; in fact, only the canals that skirt the higher elevations in the valley approach this elevation at a few points. Most of the larger irrigation canals are well below the 4,600-foot contour.



A, Mouth of Big Cottonwood Canyon, showing Bonneville Lake terraces. Wasatch Range in the distance. B, Looking up Little Cottonwood Canyon. Note U-shaped glaciated valley and terminal moraine occupied by scrub oaks and shrubs.



Looking southwest across the bottom and along the Jordan River, toward the bordering t
the Oquirrh Mountains in the background. The Logan soils of the bottom lands are u
the Welby and Taylorsville soils of the terraces are used for general farming.

The extensive deltas, formed at this and somewhat lower elevations, together with the shore lines on the mountainsides, form the most pronounced record left by the old lake. Below the Provo level (just under 4,800 feet) there are many fainter shore lines, left as the lake slowly shrank by desiccation to the recent level of the Great Salt Lake (approximately 4,200 feet). The salt content of Great Salt Lake

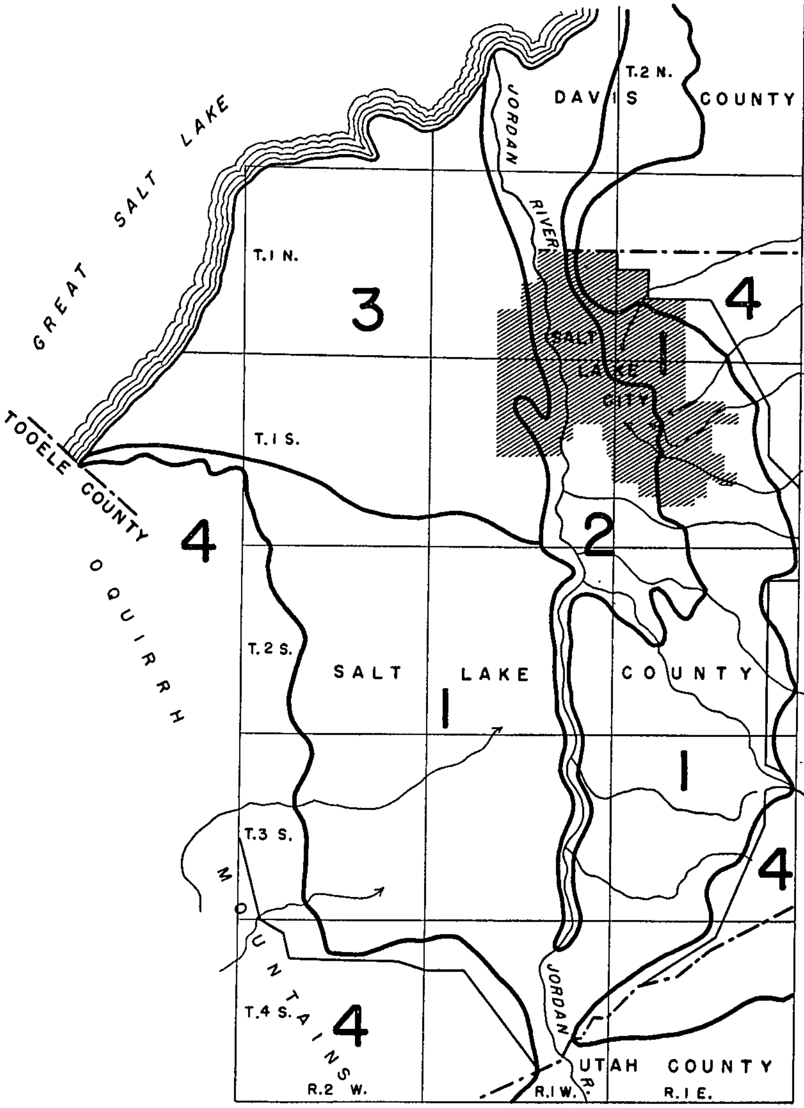


FIGURE 2.—Sketch map of the Salt Lake area, Utah, showing the principal topographic divisions: (1) Higher alluvial fans and terraces; (2) bottom lands, low terraces, and adjacent lower and flatter alluvial fans; (3) lake plain; and (4) mountains. (In addition to the area surveyed, the map includes a narrow surrounding strip.)

varies from about 15 to about 27 percent, depending on the season, the level of the lake, and the location in relation to inflowing streams. The Jordan River, after emerging from its deep channel at the Jordan Narrows, flows through a wider but shallower trough, which for the first 15 miles is bounded by series of distinct terraces to the east and west (pl. 2). Below that point the trough or bottom land runs across the east edge of the lake plain and is bordered by low and rather indistinct terraces. The bordering terraces range from 60 feet or more in height below the Narrows to barely perceptible terraces northwest of Salt Lake City. They are separated from the bottom lands by steep bluffs in some places and by comparatively gentle slopes in others.

The Salt Lake area may be considered to consist of four topographic divisions (fig. 2), as follows: (1) The higher alluvial fans and terraces that occupy the southern and eastern parts of the area and have a generally smooth and gently sloping relief, broken here and there by lake terraces or steps and cut by the channels—ranging from shallow to deep—of the Jordan River and its tributaries; (2) the bottom lands (pl. 2) and low terraces along the Jordan River and its tributaries and the lower and flatter alluvial fans that adjoin them; (3) the lake plain (pl. 3, *B*) that occupies much of the northwestern part of the area and is low and comparatively flat but has minor irregularities including low hummocks and ridges and shallow depressions (playas) and drainage channels; and (4) the rugged mountain ranges that rise on the eastern and western sides of the valley and are cut by deep gorges.

The range in elevation from the valley to the mountain tops is considerable. The level of the Great Salt Lake at the time this survey was made was approximately 4,200 feet. The highest elevation of the valley land is approximately 5,200 feet. The Wasatch Range reaches an elevation of about 11,000 feet, and the Oquirrh Mountains on the west reach approximately 10,000 feet, although these elevations are not attained within the area covered by this survey. Elevations within the valley, as shown by topographic maps of the United States Geological Survey, range from about 4,250 to about 4,800 feet in Salt Lake City and are about 4,350 feet at Midvale, 4,310 feet at Murray, and 4,435 feet at Riverton (*11*).

CLIMATE

The Salt Lake area has a semiarid continental or inland climate with well-defined seasons and considerable daily range in temperature. The climate is as warm as or warmer than that of most other areas in Utah but cooler than that in the extreme southern and southwestern parts of the State.

There is some variation of climate within the Jordan River Valley. The district adjacent to the Wasatch Mountains is somewhat warmer and has a trifle more precipitation than the center of the valley. Midvale, near the center of the valley, has an average annual temperature of 50.6° F., whereas Salt Lake City, much nearer the mountains, has an average annual temperature of 51.6°, as shown by records of the United States Weather Bureau stations at those places.

Salt Lake City has an average frost-free season of 187 days, whereas Midvale has an average frost-free season of 133 days. In Salt Lake

City the average date of the last killing frost is April 16 and of the first is October 20. The corresponding dates for Midvale are May 17 and September 26. The latest recorded date of killing frost is June 18 for both stations. The earliest recorded date of killing frost is September 22 in Salt Lake City and September 10 in Midvale.

The variation in length of growing season, combined with variation in soils, results in differences in adaptation of many different crops. The areas near the mountains are protected by air drainage and the canyon breezes are used extensively for the production of cherries. apricots, peaches, and similar fruits. Celery is an important special crop in the lower areas.

The Salt Lake area is on the windward side of the Wasatch Range, with the result that the entire valley benefits from greater precipitation than that of the adjoining desert country. From Wendover, which lies west of the Great Salt Lake, near the Utah-Nevada State line, to Saltair, the average annual precipitation increases from 4.95 inches to 13.61 inches, an increase of 8.66 inches with no increase in altitude. From Saltair to Salt Lake City there is an additional increase of 2.58 inches in annual precipitation, with only 40 feet increase in altitude, as shown by the records of the United States Weather Bureau for these stations.

There is some seasonal variation in precipitation in the area. June, July, and August are the driest months, and there is a gradual increase to a maximum precipitation in March, April, and May. In the winter a large part of the precipitation is in the form of snow. In the summer there are occasional torrential storms, but they do not occur so frequently as in southern Utah. On August 13, 1923, a storm in Salt Lake City deposited 0.30 inch of precipitation in the first 10 minutes and 1.05 inches in the first half hour.

There is not much variation in average temperature when 5-year periods are compared. The United States Weather Bureau records show that the warmest consecutive 5 years at Salt Lake City averaged 0.9° above and the coolest 1.2° below the 58-year average. There is considerable variation, however, in precipitation. The precipitation in the wettest consecutive 5 years in Salt Lake City was 118 percent and in the driest consecutive 5 years 88 percent of the average.

The Jordan River Valley is fortunately situated as to water supply. Moisture is stored in the mountains as snow during the winter, and melting snow is the main source of irrigation water in the summer. The precipitation is much greater in the mountains than in the valley. In Salt Lake City (elevation, 4,260 feet) the mean annual precipitation is 16.19 inches, and at Silver Lake (elevation, 8,700 feet), on the windward slope of the Wasatch Range, it is 43.02 inches. The valley has a high rate of water evaporation in the summer, and this increases the need for irrigation. Although the rainfall is generally high enough to allow the production of wheat under dry-farming methods that include summer fallow in alternate years, other crops require irrigation. Occasional very dry years, like 1934, seriously affect crops, not only directly, but by decreasing the supply of water for irrigation.

Table 1, compiled from data from the United States Weather Bureau, gives some of the more important climatic data for Salt Lake City.

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TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Salt Lake City, Salt Lake County, Utah*

[Elevation, 4,260 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year (1890)	Total for the wettest year (1875)	Average snowfall
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	31.9	62	−10	1.43	0.42	2.03	11.2
January	29.2	60	−20	1.31	3.07	3.05	11.5
February	33 8	68	−13	1.57	2.05	.79	10.8
Winter	31.6	68	−20	4.31	5.54	5.87	33.5
March	41.7	77	0	1.98	1.12	2.81	10.5
April	49.6	85	18	2.05	.94	1.50	3 6
May	57.4	93	25	1.92	.16	2.94	.4
Spring	49.6	93	0	5.95	2.22	7.25	14.5
June	67.4	101	32	.80	.32	.90	(1)
July	75.7	105	43	.51	.02	1.01	0
August	74.5	101	42	.85	.79	.25	0
Summer	72.5	105	32	2.16	1.13	2.16	(1)
September	64.4	97	29	.98	(1)	1.22	(1)
October	52.5	88	22	1.44	1.44	1.36	1.0
November	41.1	74	−2	1.35	(1)	5.81	5.5
Fall	52.7	97	−2	3.77	1.44	8.39	6.5
Year	51.6	105	−20	16.19	10.33	23.67	54.5

1 Trace.

VEGETATION

The native vegetation includes a wide range of species. Much of the land in the Jordan River Valley is or has been under cultivation, and on this, of course, the native vegetation has been destroyed. The original cover must therefore be inferred from that growing on small undisturbed areas or must be sought in recorded notes. At the outer rim of the valley near the base of the mountains the native vegetation includes oak brush (*Quercus* spp.), common sagebrush (*Artemisia tridentata* Nutt.), rabbitbrush (*Chrysothamnus* spp.), shadscale (*Atriplex confertifolia* Torr. (S. Wats.)), snakeweed (*Gutierrezia sarothrae* (Pursh) Britt. and Rusby), and a number of bunchgrasses including ricegrass (*Oryzopsis* spp.), slender wheatgrass (*Agropyron pauciflorum* (Schwein.) Hitchc.), and bluebunch wheatgrass (*A. spicatum* (Pursh) Scribn. and Sm.). Where the native vegetation has been largely destroyed by clearing or by overgrazing, downy chess (*Bromus tectorum* L.), commonly called cheatgrass or junegrass, has generally come in to occupy uncultivated land. Much of the land now under cultivation was probably covered by common sagebrush.

In the Stansbury report (*14*), John Torrey, a botanist attached to the Stansbury party, which explored the area about the Great Salt Lake in the fall of 1849 and the spring of 1850, has described a number of plants observed in the Jordan River Valley. Among these are evening-primrose (*Oenothera caespitosa* Nutt.), globemallow (*Sphaeralcea grossulariaefolia* (Hook. and Arn.) Rydb.), blazing-star

(*Liatris* spp.), larkspur (*Delphinium* spp.), pricklepoppy (*Argemone hispida* A. Gray), ragweed (*Ambrosia psilotachya* DC.), vetch (*Vicia americana* Muhl.), and violet (*Viola aurea* Kellogg).

On the lake plain the native vegetation, which is largely halophytic or salt tolerant, has not been greatly modified by cultivation, but overgrazing no doubt has been an important factor in changing the types of vegetation in some sections. Flowers (*5*) has made a detailed study of the vegetation of the area west of Salt Lake City. Many of the playas are barren, but he observed that the plants most prevalent on these barren playas were two species of samphire (*Salicornia rubra* A. Nels. and *S. utahensis* Tidestr.), other original species including pickleweed (*Allenrolfea occidentalis* (S. Wats.) Ktze.), sea blite seepweed (*Suaeda erecta=S. depressa* (Pursh) S. Wats., *S. fruticosa* (L.) Forsk., and *S. occidentalis* S. Wats.), and saltgrass (*Distichlis stricta* (L.) Greene). Following the original species were a number of other plants, dominated by the goosefoot family (*Chenopodium* spp.), which include halberd-leaved orache (*Atriplex hastata* L.), alkali weed (*Bassia hyssopifolia* (Pall.) Ktze.), downy chess or cheatgrass, Russian-thistle (*Salsola pestifer=S. kali* var. *tenuifolia* Tausch.), and others.

On the low terraces bordering the playas the vegetation is predominantly greasewood (*Sarcobatus vermiculatus* (Hook.) Torr.) and shadscale. Other plants include winterfat (*Eurotia lanata* (Pursh.) Moq.), white sage (*Kochia americana* var. *vestita* S. Wats.), and cottonthorn horsebrush, locally called saltbrush (*Tetradymia spinosa* Hook. and Arn.).

On the slightly higher sections of the lake plain, but with a water table seldom below 3 feet, the important plants include shadscale, greasewood, white sage, seepweed, rabbitbrush, and hop-sage (*Grayia* spp.).

The greasewood-shadscale association is the most extensive plant association in the area and is believed to be the climax vegetation in the Great Salt Lake plains-playa region. At the outer limits the association is invaded by the common sagebrush, downy chess or cheatgrass is widespread, and a number of bunchgrasses grow in some areas.

In the bottom lands of the Jordan River and its tributaries, wet areas support sedges (*Carex* spp.), rushes (*Juncus* spp.), and cattail (*Typha latifolia* L.), and somewhat drier salty areas have saltgrass, greasewood, seepweed, and other salt-tolerant species. Cottonwoods, willows, boxelders, and alders grow along the streams, and in the mountains these trees and Rocky Mountain maple (*Acer glabrum* Torr.) and scrub oaks are common.

HISTORY AND POPULATION

Although the Jordan River Valley had been visited by explorers and trappers previous to the entrance of the Mormon immigrants, settlement of the area did not begin until July 1847, when Brigham Young led a company of 143 men, 3 women, and 2 children into the valley and established a permanent camp on the banks of City Creek, in what is now the main business section of Salt Lake City. Soon after their arrival the church officials organized a civil government under title of the State of Deseret, which later became the Territory of Utah. Salt Lake County was one of the original counties formed

by the General Assembly of the State of Deseret during the winter of 1849–50. One of the important problems dealt with by the provisional State government was the orderly arrangement or settlement of the land appropriation, previous to a Federal land survey and the assumption of that function by Federal agents. The following quotations from Whitney (*16*) illustrate the way the immigrants met this problem:

The Land Question.—Wherever settlements sprang up they were upon lands claimed by the Indians and acquired by the United States at the close of the war with Mexico. The Nation was expected to deal with the Indians and in due time with the settlers, but until it took steps in this direction the people could obtain no title to their homes. Much anxiety was felt by them in consequence. While waiting for the National Government to dispose of the soil, the Provisional Government made temporary grants to its citizens, of the lands they occupied, including the use of grazing ground, with water and timber for milling and lumbering purposes.*

[Footnote.] *Twenty years passed, after the settlement of Salt Lake Valley, before the United States land laws were fully extended over this region; though a Surveyor-General was appointed for Utah and tracts of land surveyed under his authority as early as 1855. The Pioneers distributed their lots and fields by ballot, each city lot costing its holder one dollar and a half, with small fees for surveying and recording. Under the Provisional Government, a "right of occupancy" was issued by the State which was to answer the purpose of a title until the General Government surveyed the lands and put them on the market.

Events of great importance to Utah, but particularly to Salt Lake County, were the establishment of the Pacific Telegraph Line (*15*), built from the east and the west, and completed in Salt Lake City in October 1861, and the completion of the first transcontinental railroad at Promontory Summit, Utah, on the north shore of the Great Salt Lake. Here on May 10, 1869, the Central Pacific line from the west and the Union Pacific from the east were joined to make one line across the continent. Within a few months after this important event the Utah Central, a branch line extending from Ogden to Salt Lake City, was completed. This enterprise was sponsored and prosecuted by the Utah pioneers.

Various classes of people came to Salt Lake City in the early days—farmers, laborers, tradesmen, mechanics, merchants, manufacturers, and business men, together with some artists, musicians, writers, and other professionals.

The population of Salt Lake County as reported by the United States census for 1850 was 6,157, of which 6,142 were white and 15 were free colored. By 1940 the population had increased to 211,623, as shown by the Federal census for that year. Included in the total are 191,533 native white, 18,280 foreign-born whites, 781 Negroes, and 1,029 people of other races. By far the largest number of people live in Salt Lake City, the 1940 census showing 149,934 inhabitants there, with only 61,689 in the other towns and in rural sections.

Salt Lake City is the county seat and the State capital. It is a wholesaling, manufacturing, and distributing center, not only for the area surveyed but for territory with a radius of 100 miles or more. Important towns and cities of the area are Murray, Midvale, and Magna, which are primarily ore-milling and smelting towns, although they also have importance as agricultural centers. Draper, Sandy, Riverton, Taylorsville, West Jordan School, South Jordan, Herriman,

Bluffdale Station, and Granger are primarily agricultural centers. Holladay, Crescent School, Granite Church, Butlerville School, and Union are smaller community centers of mixed agricultural and suburban residential districts.

RURAL CULTURE

The farm population of Salt Lake County has a comparatively high standard of living. The entire Jordan River Valley is comparatively close to urban centers of trade and consequently has access to a ready market for purchasing commodities essential to a well-balanced home life. Most farmers own automobiles. According to the United States agricultural census for 1940, 1,841 farm operators out of a total of 2,515 in the county reported the ownership of 2,111 automobiles; 2,351 farm dwellings were lighted by electricity, and 625 homes had telephones. The rural areas are adequately supplied with free public schools and modern churches. There is practically no illiteracy among the rural population. The predominating church is that of the Latter-Day Saints, or Mormons, although a number of other denominations are represented in the larger cities and towns.

TRANSPORTATION AND MARKETS

Since the area is an inland area far removed from any navigable streams, it must depend entirely on railroads, highways, and air lines for transportation to the outside world. The area is adequately supplied with railroads, as several trunk lines either enter it directly or make contact through other lines. They are (1) the Union Pacific to Los Angeles, Calif.; (2) the Western Pacific to San Francisco; (3) the Southern Pacific to San Francisco via Ogden, Utah; (4) the Union Pacific, also via Ogden, to the East; (5) the Denver & Rio Grande Western to Denver, Colo., and east; and (6) the Union Pacific to Idaho, Montana, and the Pacific Northwest. A number of minor railroads and interurban electric lines extend south into Utah County and north through Cache Valley to Idaho and to mining towns to the east and west.

Prominent highways also connect the Salt Lake area with other areas. They include United States Highways Nos. 40 and 50, connecting the area with the eastern United States and with San Francisco on the west; United States Highway No. 91, extending into Idaho and Montana to the north and to Los Angeles to the southwest; and United States Highway No. 89, extending into Arizona via southern Utah. Salt Lake City forms a junction for several well-established air lines.

The 1940 census reports that out of a total of 2,515 farms, 1,779 were located on hard-surfaced roads, 184 on gravel, shale, and shell roads, 347 on improved dirt roads, and the rest on unimproved dirt roads.

Certain crops grown in the area are consumed on the farms, whereas others are marketed at urban centers or shipped to outside markets. Practically all of the hay is consumed by the dairy herds and other livestock in the area. As one-third of the chickens in Utah are in Salt Lake County, the quantity of grain consumed by poultry and livestock is greater than the quantity produced within the county.

Salt Lake City furnishes the largest market for the farm products

of the valley. Most of the dairy products, a large proportion of the vegetables and fruits, and much of the livestock in the form of meat are consumed there.

Among the more important agricultural products shipped to outside markets are livestock, poultry products, and fresh celery. One sugar factory and a few vegetable canning factories operate in the valley.

INDUSTRY AND BUSINESS

By far the larger numbers of personnel employed in Salt Lake County are employed by industry and business. The 1940 census reports a total personnel of 66,709, of whom 49,773 are associated with industries and business located in Salt Lake City. This city is a wholesale and financial center for the surrounding territory, including most of Utah and extending into neighboring States. In 1940 there were employed in Salt Lake County 3,554 persons in the wholesale trade and 3,230 in finance, insurance, and real estate. These represent 66.2 and 73.3 percent, respectively, of the total number of persons employed in Utah in their respective types of business.

The Great Salt Lake and the mountains adjacent to the Jordan River Valley contain a wealth of minerals. According to Boutwell (*2*), 80,000 tons of salt is produced annually by the solar process from areas bordering the Great Salt Lake. Within the Bingham mining district, west of the Jordan River Valley, on the eastern slope of the Oquirrh Mountains, is the largest producing copper mine in North America. This mine alone, working chiefly by open-cut methods, has a daily output of 50,000 to 60,000 tons of ore (*3*). Other minerals, such as those containing lead, silver, and zinc, are also mined in the Bingham district. To the east of the Jordan River Valley, along the crest of the Wasatch Range, are the Cottonwood mining districts. These districts contain rich deposits of silver, copper, lead, and gold.

The Salt Lake area is the smelting center of Utah. There are several smelting plants in the valley, which process not only the ore obtained within the borders of Salt Lake County but also ore from the mining districts in other parts of the State. The most outstanding of these districts are the Park City district, in the eastern slope of the Wasatch Range, which produces mainly lead and silver, and the Tintic district, in the East Tintic Mountains, which produces mainly lead, silver, gold, and copper.

The Salt Lake City Chamber of Commerce [4] reports that the leading industries in the city, more or less in the order of their importance, are oil refining, printing and publishing, butter making, baking, confectionery manufacturing, clay products, planing mills, canning and preserving, structural steel fabrication, foundry and machine shops, textiles, cement, and mattress making.

AGRICULTURAL HISTORY AND STATISTICS

One of the first undertakings of the Mormon pioneers after reaching the Jordan River Valley in 1847 was the diversion of the water of

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[4] HART, R. A. SALIENT AND ECONOMIC FEATURES OF SALT LAKE CITY AND UTAH. Rev. by Harold S. Jennings. 16 pp. Salt Lake City Chamber of Commerce. [Processed.]

what is now known as City Creek, and the irrigation of a few acres of land planted with seed brought with them on their long and perilous journey from Illinois (*17*). The practice of irrigation spread rapidly. In 1848, 5,153 acres were put under irrigation. By 1899 the irrigated land in Salt Lake County had increased to 54,598 acres, by 1909 to 82,710 acres, and by 1919 to 102,051, according to United States census reports. In 1909 there were 95 main ditches totaling 298 miles in length. There has been no extensive expansion of irrigation in this valley since that time. The earliest development of irrigation was made by diversion of water of the smaller streams flowing from the mountains. As expansion took place, use was made of the larger streams. The first large canal to divert water from the Jordan River was the North Jordan Canal, the construction of which was begun in 1853 (*7*). Irrigation of the higher lands has resulted in water-logging of a part of the lower or bottom lands, thus necessitating the discontinuance of their use for cultivated crops.

Many of the crops now grown in the Jordan River Valley were introduced during the early history of the area. The crops planted the first year the Mormons arrived were wheat, buckwheat, corn, oats, potatoes, beans, and garden vegetables. Wheat, which was the principal crop, was grown mostly without irrigation in the early period, but far greater yields were obtained when irrigation was used. Modern methods of growing dry-land wheat, which made it possible to farm the west side of the valley, were not put into practice until the first decade of the twentieth century. Alfalfa was introduced into the area in the 1860's and soon became the main forage crop. Attempts were made to manufacture sugar from sugar beets during the first decade of settlement, but this industry was not successful until about 1891. After this, sugar beets became an important crop. The growing of fruits and vegetables for market has paralleled fairly closely the growth in population of Salt Lake City.

The acreage of the dominant crops in 1929, 1934, and 1939, as shown by the United States census, are given in table 2.

TABLE 2.—*Acreage of the principal crops of Salt Lake County, Utah, in 1929, 1934,*[1] *and 1939*

Crop	1929	1934	1939
	Acres	*Acres*	*Acres*
Winter wheat	11,318	8,864	9,313
Spring wheat	6,993	5,971	4,861
Barley	1,632	1,502	3,849
Oats	1,689	929	978
Hay	28,294	14,715	13,727
Potatoes	1,422	593	468
Vegetables harvested for sale	1,957	1,212	1,509
Sugar beets	2,948	583	3,843
Land in orchards, vineyards, and planted nut trees	1,927	1,982	1,239

[1] In 1934, crop acreages and yields were low, because of the severe drought; therefore the statistics for this year do not represent normal agricultural conditions.

Winter wheat is produced mainly on dry-farmed land, whereas nearly all of the spring wheat is grown on irrigated farms. More than 95 percent of the acreage harvested for hay is in alfalfa. A large proportion of the grasses from the poorly drained areas are grazed off by livestock. Many types of vegetables are harvested for sale in Salt

Lake County. A few, however, are grown more extensively than others. The predominating vegetables grown in 1939 were celery, 267 acres, and tomatoes, 152 acres. The predominating fruits and their yields in the same year were apples, 51,044 bushels; peaches, 28,887 bushels; pears, 10,253 bushels; cherries, 167,783 pounds; plums and prunes, 74,445 pounds; and apricots, 393,808 pounds.

The raising of livestock in the Jordan River Valley began with the introduction of agriculture into the valley. It first took the form of grazing cattle on the virgin areas, but soon expanded to the grazing of cattle and sheep on the adjacent mountain and desert areas. The sheep industry reached a peak about 1900, but since then, because of more intensified agriculture and governmental restrictions, the number of sheep has declined considerably. A decrease in the number of beef cattle has been more than compensated by an increase in the number of dairy cattle, resulting from a growing demand for fluid milk, accompanying the growth of Salt Lake City. In 1939 there were 5,675 cows milked and 3,640,778 gallons of milk was produced, most of which was sold as fluid milk. The poultry industry is also of major importance in the valley. In 1939, 741,936 chickens were raised and 5,533,796 dozen eggs produced, and 78,016 turkeys were raised.

Soil fertility is maintained largely by the use of barnyard manure and forms of soluble phosphate, usually treble superphosphate. The manure produced is well cared for and efficiently used. Complete commercial fertilizers are applied to a very slight extent and only by truck farmers. Only meager data are available concerning the response of crops to the application of complete fertilizers, but the county agricultural agent reports that some increase in yield probably results. Out of 12 field fertilizer tests conducted by Pittman and Burnham (*12*) in Salt Lake County, 3 fields responded to phosphate and 2 to nitrogen treatments.

According to the United States census for 1940 there were 423 farms reporting a total expenditure of $13,194 for fertilizer during the year 1939. The county agent reports that approximately 215 tons, largely treble superphosphate, was applied to Salt Lake County farms in 1938. This quantity of fertilizer was purchased mainly by 800 farmers for application to 5,300 acres in sugar beets in 1938. The fertilizer is applied by the drill at the time of seeding. It is estimated that 75 percent of the farmers applying the treble superphosphate for beets receive significant responses.

A large proportion of the farm labor in the Salt Lake area is performed by the farm operator and his family. Many of the small farms are operated by men who spend much of their time working in other industries, agriculture being of secondary importance. Several of the larger farms, however, employ permanent labor. In 1939, $314,922 was spent for labor on 952 farms. The census of 1935 reports that 53.6 percent of all farm operators in 1934 obtained employment not connected with their farms. Only 47 operators reported agriculture as the principal occupation off their farms, whereas 1,120 reported nonagricultural pursuits as the principal occupation off the farm. These figures are for a year (1934) in which the drought prevailed; consequently the farmers went elsewhere for employment, a large part of which was furnished by Government work projects.

The average size of farms in Salt Lake County is continually changing. During the years of agricultural expansion it increased, as the introduction of dry farming was especially conducive to large farms. In recent years the tendency has been toward smaller farms. Table 3 gives the number and acreage of farms by size of farm in 1920, 1930, and 1940. There has been a large increase in the number of farms under 10 acres, and some decrease in farms above 50 acres. Factors responsible for such a large increase in the number of very small farms are (1) increase in farm population and consequent subdivision of property, and (2) more intensive agriculture resulting from the increase of urban population.

TABLE 3.—*Number of farms and farm acreage by size of farm in Salt Lake County, Utah, in stated years*

Farms	1920		1930		1940	
	Number	*Acres*	*Number*	*Acres*	*Number*	*Acres*
Under 10 acres	581	3, 195	1, 026	4, 247	1, 010	4, 517
10 to 19 acres	428	5, 922	544	7, 247	489	----------
20 to 49 acres	768	24, 048	805	25, 514	603	----------
50 to 99 acres	349	23, 713	303	20, 303	226	15, 484
100 to 174 acres	149	19, 271	135	17, 154	90	11, 674
175 to 259 acres	56	11, 588	56	11, 768	37	7, 820
260 to 499 acres	53	18, 176	34	11, 341	27	9, 423
500 to 999 acres	19	13, 827	15	9, 067	20	13, 555
1,000 acres and more	35	197, 541	14	27, 941	13	40, 755

A large percentage of the farms in Salt Lake County are operated by the owners. The census of 1940 reports more owners than tenants for all classes of farms except self-sufficing farms. Some farms are operated by persons who own a part and rent the rest of the land they operate. In 1940 there were 37,364 acres of land with this status, including 18,626 acres that were owned and 18,738 acres rented. Only a few farm operators are listed as managers. The proportion of tenancy is listed as 11.4 percent. There are both cash tenants and share tenants, the former being somewhat more numerous. In 1940 the farms were operated as follows: By full owners, 1,949; part owners, 264; managers, 15; and tenants, 287. Of the tenants there were 177 who rented for cash and 110 sharecroppers and others.

Nearly all of the early settlers of Salt Lake County were Mormons, who came to Utah to obtain religious freedom. They were practically 100 percent Nordic and came mainly from the eastern United States and northern Europe. White people have dominated the immigration into the county up to the present time. The census for 1940 shows that the nonfarm population of the county is far in excess of the farm population. The urban population is 167,084 and the rural 44,539. The composition of the farm population is as follows: Native white, 10,195; foreign-born white, 894; Negro, 30; other races, 112.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field and the recording of their characteristics, particularly in reference to the growth of various crops, grasses, and trees.

The soils and the underlying formations are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of layers or horizons, called collectively the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail, and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil[5] and its content of lime and salts are determined by simple tests.[6] The drainage, both internal and external, and other external features, such as relief or lay of the land, are taken into consideration, and the interrelation of the soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, with special emphasis upon the features that influence the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics the soils are grouped into classification units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land—such as coastal beach or bare rocky mountainsides—that have no true soil are called (4) miscellaneous land types; and where two or more soil types or phases occur in small areas so intimately associated that they cannot be shown separately on a small-scale map they are called (5) complexes.

The series is a group of soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile and having similar parent material. Thus, the series comprises soils having essentially the same color, structure, natural drainage conditions, and other important internal characteristics and the same range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The series are given geographic names taken from localities near which they were first identified. Welby, Taylorsville, and Bingham are names of important soil series in the Salt Lake area.

Within a soil series are one or more types, defined according to the texture of the upper part of the soil. The class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, or clay, is added to the series name to give the complete name of the soil type. For example, Welby loam and Welby fine sandy loam and soil types within the Welby series. Except for the texture of the surface soil, these types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the unit to which agronomic data are referred.

A phase of a soil type is a variation within the type, differing from the type in some minor feature, generally external, that may be of special significance. Differences in relief, stoniness, and degree of accelerated erosion may be shown as phases. For example, within the normal range of relief for a soil type some areas may be adapted to the use of machinery and the growth of cultivated crops and others may not. Even though there may be no important differences in the soil

[5] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality; higher values indicate alkalinity, and lower values acidity.

[6] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in the growth of cultivated crops. The more sloping parts of such soil types are segregated on the map as a sloping or a hilly phase. Similarly, some soils having differences in stoniness may be mapped as a phase, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of the soil types, phases, complexes, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The soils of the Salt Lake area, like those of most arid and semiarid regions, are rich in mineral plant nutrients. In poorly drained areas and even in many places where drainage is good, the more soluble mineral salts, commonly called "alkali"[7], have accumulated, especially in the subsoil. Calcium carbonate (lime) and calcium sulfate (gypsum) are common constituents in most of the soils, although they are lacking in some of the soils derived from granitic and other siliceous materials. The soils have considerable range in content of organic matter and nitrogen, from low to high; but the more extensive soils contain a moderate quantity, and the content is considerably more than that in most soils of the drier and warmer parts of the West and the Southwest. The upper layers of a number of the more extensive soils contain little or no lime and gypsum, and apparently these compounds have been leached downward and accumulated in the subsoils. The majority of the soils are alkaline in reaction, although a few of them have approximately neutral surface layers. Because of the alkalinity of the soils and their high content of lime, most of the phosphorus is in comparatively insoluble form, and as a result some crops, particularly sugar beets, are benefited by the addition of phosphorus in some readily available form, such as superphosphate.

Agriculture is carried on principally with the aid of irrigation, although dry farming is practiced to some extent. Dry farming, which consists of a year of fallow followed by a year of small grain, usually wheat, is confined largely to the southwestern part of the area, extending nearly to the foothills of the Oquirrh Mountains. According to a recent census of the Agricultural Adjustment Administration, 26,600 acres of land are used for dry farming in the Salt Lake area.

Irrigation farming consists of the following two general types: (1) General farming, which consists largely of the growing of alfalfa, small grains, and sugar beets, together with comparatively small acreages of potatoes and corn; and (2) specialized farming, which consists of truck gardening and fruit growing. Specialized farming is carried on south and east of Salt Lake City. In many places successful truck gardening is done on soils in which the water table is within 6 feet of the surface. Careful irrigation and the growing

[7] The term "alkali" in this report is used in its common or agricultural sense and refers to readily soluble mineral salts that are generally neutral in reaction.

of shallow-rooted crops make such a practice possible. These areas, however, would not be well adapted to a rotation in which alfalfa was the major crop. Fruit growing is carried on successfully on the higher lands where both soil drainage and air drainage are good. The lighter textured soils are often used to advantage for fruit production.

The farmer or rancher must seek a living by irrigation farming, dry farming, stock raising, or a combination of these; and the soils must lend themselves to one of these enterprises or to a combination of two or more of them.

On the basis of topographic position, relief, drainage, moisture-holding capacity, and internal soil characteristics, the soils of the area have been classified in 5 broad groups having a general relation to land use, as follows: (1) Well-drained soils of the terraces and alluvial fans, from medium- to fine-textured materials; (2) well-drained and excessively drained soils of the higher alluvial fans, underlain by sand and gravel; (3) imperfectly and poorly drained soils of the bottom lands and of the lower and flatter areas on the terraces and alluvial fans; (4) poorly drained salty soils of the lake plain; and (5) miscellaneous soils and land types, largely nonarable.

Each of these groups includes a rather wide variety of soils, and each may be considered to be composed of a number of subgroups. A grouping that shows both broad groups and subgroups is included in the appendix.

Although the range in soils, drainage, salt concentration, and suitability for use is rather great in each broad group, each group may be described in a general way and general statements made as to the relative suitability of the soils for the various agricultural uses.

The well-drained soils of the terraces and alluvial fans are, for the most part, well adapted to general farming under irrigation. The well-drained and excessively drained soils of the higher alluvial fans are less suitable for general farming under irrigation, though some areas are well suited to the production of fruits, and some are fairly well adapted to dry-farmed production of wheat. The imperfectly and poorly drained soils of the bottom lands and low terraces and fans vary greatly in suitability for use, depending on drainage condition and content of salts, but many areas are well suited to pasture and truck crops and most areas could be improved by drainage. The poorly drained salty soils of the lake plain are very poorly suited to the production of crops, and have low value for pasture but have some industrial and recreational uses. The miscellaneous soils and land types are largely nonarable, but some areas have value as residential and industrial sites, and others furnish range for livestock. A more detailed discussion of each soil group is given under separate headings.

In the following pages the soils and land types are described in detail and their agricultural use is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in table 4.

TABLE 4.—*Acreage and proportionate extent of the soils mapped in the Salt Lake area, Utah*

Type of soil	Acres	Percent
Welby loam	11,648	4.1
Welby loam, sloping phase	1,536	.5
Welby loam, hardpan phase	320	.1
Welby fine sandy loam	6,400	2.2
Welby fine sandy loam, sloping phase	448	.2
Welby silty clay loam	1,600	.6
Taylorsville silty clay loam	12,800	4.5
Taylorsville silty clay loam, hardpan phase	512	.2
Taylorsville silty clay loam, shallow phase (over Bingham soil material)	1,088	.4
Taylorsville loam	5,056	1.8
Taylorsville loamy fine sand	1,088	.4
Parleys loam	832	.3
Parleys loam, gravelly phase	384	.1
Parleys silty clay loam	384	.1
Avon gravelly loam	1,600	.6
Decker loam, well-drained phase	1,792	.6
Red Rock loam	7,744	2.7
Red Rock clay loam	1,344	.5
Red Rock silty clay loam	3,200	1.1
Red Rock fine sandy loam	2,368	.8
Red Rock gravelly loam	1,664	.6
St. Marys loam	384	.1
Draper loam	832	.3
Draper coarse sandy loam	640	.2
Bingham gravelly loam	19,712	6.9
Bingham gravelly loam, deep phase	640	.2
Bingham gravelly loam, steep phase	1,280	.5
Bingham very gravelly loam	1,728	.6
Bingham gravelly fine sandy loam	2,048	.7
Bingham loam	4,672	1.6
Bingham loam, deep phase	4,928	1.7
Bingham coarse sandy loam	640	.2
Bingham fine sandy loam	1,024	.4
Churchill loam	2,496	.9
Knutsen gravelly loam	1,664	.6
Knutsen loam	896	.3
Wasatch coarse sandy loam	8,064	2.8
Wasatch gravelly coarse sandy loam	2,304	.8
Wasatch sand	1,344	.5
Wasatch loamy sand	640	.2
Wasatch sandy loam, shallow phase (over Welby soil material)	2,496	.9
Wasatch loam	1,216	.4
Welby loam, poorly drained phase	2,560	.9
Welby fine sandy loam, poorly drained phase	768	.3
Taylorsville silty clay loam, poorly drained phase	5,312	1.9
Taylorsville silty clay loam, overwash phase	256	.1
Red Rock fine sandy loam, poorly drained phase	768	.3
Red Rock silty clay loam, poorly drained phase	384	.1
Wasatch coarse sandy loam, poorly drained phase	1,216	.4
Wasatch sandy loam, shallow poorly drained phase (over Welby soil material)	640	.2
Knutsen loam, poorly drained phase	320	.1
Draper loam, poorly drained phase	256	.1
Draper loam, shallow phase (over Taylorsville soil material)	192	.1
Decker loam	2,304	.8
Decker sandy loam	1,472	.5
Logan clay	5,568	1.9
Logan silty clay loam	4,224	1.5
Logan silty clay loam, alluvial-fan phase	1,600	.6
Logan loam	4,928	1.7
Logan loam, alluvial-fan phase	1,152	.4
Gooch clay loam	896	.3
Gooch loam	1,280	.5
Airport loam	14,400	5.0
Airport loam, deep phase	704	.2
Terminal loam	18,112	6.3
Terminal silty clay loam	6,976	2.4
Saltair clay	20,608	7.2
Saltair clay, mucky phase	1,536	.5
Bingham stony loam	6,976	2.4
Wasatch stony loam	2,240	.8
Preston fine sand	1,344	.5
Oolitic sand	1,600	.6
Rough broken land (Bingham soil material)	13,120	4.6
Rough broken land (Wasatch soil material)	2,944	1.0
Rough broken land (Welby and Taylorsville soil materials)	1,280	.5
Rough broken and stony land	19,776	6.9
Riverwash	576	.2
Pits and dumps	8,064	2.8
Unclassified city land	6,272	2.2
Total	286,080	100.0

WELL-DRAINED SOILS OF THE TERRACES AND ALLUVIAL FANS

In general, the well-drained soils of the terraces and alluvial fans are well suited for general farming, including the growing of a rather wide variety of crops under irrigation, and are fairly well suited to growing wheat under dry farming. They have, for the most part, a fairly smooth surface favorable for tillage and the distribution of irrigation water; they are composed largely of medium- to fine-textured materials; and they have good depth, good drainage, and medium to high water-holding capacity. With minor exceptions they are free from excessive quantities of gravel and stone and from injurious accumulations of salts. Some small gravelly areas and others that are too steep or uneven to be favorable for cultivation and irrigation are included. The soils of this group comprise much of the better agricultural land of the Salt Lake area.

This group has two subgroups: (1) Mature (zonal) soils with distinct concentration of lime in the subsoils, and (2) immature (azonal) soils with little or no distinct concentration of lime in the subsoils. The first group includes all the soils of the Avon and Parleys series and all those of the Welby and Taylorsville series except relatively small poorly drained areas that owe their poor drainage to seepage from irrigation. It also includes a well-drained phase of Decker loam. The second group includes the St. Marys soils and all the Red Rock and Draper soils with the exception of small poorly drained areas.

WELBY SERIES

The Welby soils occupy comparatively smooth, gently sloping areas on lake and river terraces and alluvial fans. Typically they are well drained, although a few of the lower lying and flatter areas have imperfect or poor drainage due to seepage of water from higher, irrigated land.

These soils have developed from medium- to fine-textured, more or less stratified, alluvial and lake-laid materials. They are typically calcareous throughout and have a distinct concentration of lime in the subsoils. The surface soils are brown or brownish gray and friable. The layer of lime concentration, lying at an average depth of about 18 inches and continuing to about 2 or 3 feet, is light gray and somewhat compact but readily permeable. The underlying materials are stratified and range in texture from clay to sand, but are dominantly medium-textured, fairly open, and permeable. In some places brown or rust-brown sandy materials are present.

These soils are similar to those of the Taylorsville series but have been developed from materials that contain less clay. They are therefore more open and permeable and allow freer and more rapid penetration of water, roots, and air. They commonly occur on slightly higher lying land than the Taylorsville soils.

Most areas of Welby soils are very well suited to the production of a wide variety of crops under irrigation, but the included areas of poorly drained and salty soils are not well adapted to cultivation.

Welby loam.—This is the dominant soil type in the Welby series. It covers a total of 11,648 acres and is well distributed throughout the valley. Areas of this soil occur in all but 5 of the 19 townships included in the surveyed area. Welby loam commonly occupies terraces and gently sloping alluvial fans somewhat lower than adjoining areas of the Bingham and Wasatch soils and slightly higher than areas of the Taylorsville soils.

The surface soil is brown or brownish-gray friable loam that is slightly to distinctly calcareous. At an average depth of about 18 inches a definite concentration of lime carbonate occurs, and this continues to a depth of 3 to 4 feet and in a few places to a greater depth. The entire subsoil below 18 inches, however, is highly calcareous. The soil material to a depth of about 1½ to 2 feet is commonly a loam and overlies stratified materials of variable texture. These materials range from sandy loam to silty clay loam, with the coarser textured layers predominating. In many places, however, the entire subsoil consists of loam or fine sandy loam, and in a few bodies the fine sandy loam has a light-yellow color.

This is one of the most desirable soils in the area. Much of it is under irrigation and is well adapted to the production of sugar beets, alfalfa, grain, and potatoes. Acre yields of alfalfa range from about 2½ tons to about 5 tons, with an average of about 4 tons. Sugar beets yield from about 9 to about 23 tons an acre, with an average of about 16.3 tons. The low acre yield for wheat is estimated at about 30 bushels, with a high of nearly 60 bushels and an average of about 43 bushels. Yields of oats and barley are somewhat higher than those of wheat. Potato yields are very good, and according to estimates of farmers they range from 240 bushels to 540 bushels an acre, with an average of about 400 bushels. There are a few orchards on this soil, and apples are doing very well. Welby loam absorbs water under irrigation more readily than does Taylorsville loam, but it has a somewhat lower moisture-holding capacity. In a number of localities this soil lies too high to be irrigated from present sources of water, and here it is a desirable soil for dry farming. Estimates of wheat yields under dry farming definitely place this soil above Bingham loam in value.

Welby loam as mapped has some range in texture. One small body of about 20 acres on the section line between secs. 21 and 28, T. 1 N., R. 1 W., is slightly coarser textured than is typical. In W½SW¼ sec. 26, T. 2 S., R. 2 W., is an area of about 25 acres that has a gravelly and stony subsoil.

Some of the areas of Welby loam west of the Jordan River contain sufficient gravel in the surface soil to interfere somewhat with cultivation or to modify the water-holding capacity of the soil. The gravel is confined largely to the topmost foot of soil; however, in some places it extends somewhat deeper, and the content varies greatly from place to place. These areas are small and widely scattered and are indicated on the soil map by gravel symbols. In one area of about 140 acres, about half a mile west of Bennion; in an area of about 65 acres in sec. 1, T. 1 S., R. 2 W.; and in a third area of 10 acres in sec. 30, T. 1 N., R. 1 W., the gravel is of fine angular character and consists largely of quartzite with some granitic material. In an area in sec. 15, T. 4 S., R. 1 W., stones and boulders 1 to 2 feet in diameter occur in addition to the gravel; and in three small areas in secs. 5 and 30, T. 3 S., R. 1 W., and in sec. 26, T. 2 S., R. 2 W., gravel and stones occur only in the subsoil.

The gravelly areas are used mainly for the production of alfalfa and grain. Yields as a general rule, are lower than on the gravel-free areas, and irrigation requirements are higher.

The total extent of the gravelly areas is about 500 acres.

Welby loam, sloping phase.—This phase is like typical Welby loam except that it lies on steeper slopes and generally has a thinner and lighter colored surface soil, which, where not covered by thick-growing vegetation, is rather susceptible to erosion. This soil generally lies on the long, narrow terrace fronts or slopes leading down from the higher terraces to the lower terraces or bottom lands. It is most extensive on the slopes bordering the Jordan River bottoms. A total of 1,536 acres is mapped in this area.

This land, because of its comparatively steep and uneven slopes, is not so well adapted to the production of crops under irrigation as is typical Welby loam. Small areas are used for the production of small

grains, alfalfa, and fruit under irrigation and of wheat under dry farming, but the greater part is used for pasture, some of which is irrigated. Distribution of irrigation water is more difficult than on the smoother and more gently sloping typical Welby loam.

Some areas of this soil appear to be fairly well adapted to the growing of tree fruits and grapes.

Welby loam, hardpan phase.—This phase is almost identical with typical Welby loam to a depth of 4½ or 5 feet, where it is underlain by a layer of lime hardpan that appears to be spring-deposited travertine. From the point of view of crop yields this soil appears to be about equal to typical Welby loam. Most of it occurs on slopes that are somewhat too steep to be ideal for irrigation, and care with the use of irrigation water is essential to prevent erosion of the soil and waste of water. It seems probable that too large applications of water would lead to waterlogging, as the hardpan layer doubtless interferes somewhat with deep percolation.

About 320 acres is the extent of this soil, which occurs in a number of areas south and east of Magna, in the vicinity of Monroe School.

Welby fine sandy loam.—This soil type is confined largely to the southern and central part of the area. It covers a total of 10 square miles. The surface layer is slightly darker in color and coarser in texture than Welby loam and is generally calcareous. The subsurface layer, between depths of 6 and 16 inches, is lighter in color and distinctly higher in lime carbonate than the surface layer. At a depth of about 16 inches a definite compaction, together with a light-gray color, has developed. This layer represents a concentration of carbonate of lime and extends to a depth of nearly 3 feet. Between depths of 3 and 6 feet the material is uniform light brownish-gray highly calcareous fine sandy loam. There is sufficient body in this soil to make it fairly retentive of water. The surface soil is fairly uniform in texture, but the subsoil ranges from fine sandy loam to somewhat heavier textured material.

This is one of the more desirable soils of the area. According to yield estimates by farmers, it is slightly more productive than Welby loam for alfalfa and has about the same productivity for sugar beets, wheat, oats, barley, and potatoes. It is somewhat less desirable, however, than Welby loam, because it is more subject to drifting by wind and to erosion by water. In a number of locations considerable damage has resulted from gullies caused by the careless use of irrigation water.

Welby fine sandy loam, sloping phase.—This phase lies mainly in T. 2 S., R. 1 E., and in Tps. 2 and 3 S., R. 1 W. It occurs in narrow, irregular-shaped bodies, mostly on terrace fronts or escarpments. The slopes are sufficiently steep, ranging from about 5 to 9 percent, to make irrigation difficult until a sod is established, and care is essential to prevent erosion. The surface soil is thinner and lighter in color than in typical Welby fine sandy loam. The total extent of this soil is 448 acres. An area of about 40 acres, about half a mile southwest of the junction of the Bluffdale road and United States Highway No. 91, has a somewhat coarser or grittier surface soil but is otherwise typical.

The chief use of this soil is for pasture, although a small acreage is used for general farm crops and fruits. The soil appears to be fairly well adapted to tree fruits and grapes in places.

Welby silty clay loam.—Except for its somewhat heavier texture in both surface soil and subsoil, Welby silty clay loam resembles Welby loam and Welby fine sandy loam. It also resembles the Taylorsville soils. In surface soil features as well as in its permeability to water, Welby silty clay loam is definitely related to the other Welby soils. The subsoil is finer than that of the other Welby soils, but it is stratified and distinctly coarser in texture and more permeable than the subsoil of Taylorsville silty clay loam.

Areas in which the surface soil is clay loam are included with this soil. This variation, the extent of which is about 200 acres, occurs principally in three areas, two of which are half a mile east of Midvale and the third near the center of sec. 3, T. 2 S., R. 1 E., in the vicinity of Holladay.

The surface soil of Welby silty clay loam is somewhat too heavy to be ideal for cultivation, but with good cultural treatment a desirable granulation readily develops. Under normal conditions the soil is well drained. The crops grown on Welby silty clay loam are the same as on Welby loam, but farmers' estimates of acre yields are somewhat lower with all crops.

The extent of this soil, which is located mainly in the south-central part of the area, is 1,600 acres.

TAYLORSVILLE SERIES

The soils of the Taylorsville series have developed from old lake-laid deposits of fine texture (pl. 2). They occur mostly on an extensive terrace situated at a slightly lower elevation than that on which the Bingham soils generally occur, although a number of areas occupy higher or lower terraces (pl. 4, *B*). The surface soils are typically brownish gray in color and are slightly but distinctly calcareous. The upper subsoil layers are brownish gray mottled with lime and fairly compact, and at an average depth of 18 inches or slightly more there is a light-gray or nearly white layer of accumulated lime carbonate. The underlying soil material generally consists of pinkish-gray, light brownish-gray, or gray compact blocky clay, which becomes light gray when dry.

The Taylorsville soils are used for general farming under irrigation. Sugar beets, alfalfa, corn, and the small grains do well on all soils of this series. The soils are especially well adapted to the production of alfalfa and sugar beets.

Taylorsville silty clay loam.—This is the most extensive soil of the Taylorsville series. It covers an area of 20 square miles. Its greatest extent is in the south-central part of the area.

The surface layer, to an average depth of 10 to 12 inches, is brownish-gray silty clay loam or heavy silt loam, which generally has a desirable granular or crumb structure. The subsurface layer, extending to a depth of about 20 inches, is fairly compact, and below it is a still more compact light-gray layer of lime carbonate concentration, extending to an average depth of about 36 inches. This limy material may be crumbled rather easily to a finely divided or granular condition, especially when not too dry. In many places, especially west of the Jordan River, this material has a speckled or salt-and-pepper appearance. The white lime carbonate is distributed in small spots and streaks throughout what was originally a brownish-gray soil mass. Although the soil material in this layer has a high concentration of

lime, there is little or no indication of cementation. The layer below the gray carbonate layer consists of compact hard silty clay loam or clay, which on exposure breaks readily into irregular-sized angular blocks or prisms. In the vicinity of Riverton and to some extent on the east side of the valley the gray carbonate layer begins at a greater depth and extends deeper than is typical for this soil.

The principal crops grown on this soil are alfalfa, wheat, barley, oats, and sugar beets. Crops of minor importance are corn, potatoes, and peas. Alfalfa yields range, according to estimates of farmers, from 2½ to 6½ tons an acre, with an average of about 4 tons. Wheat yields range from 30 to 55 bushels an acre, with an average of about 43 bushels. Both barley and oats return somewhat higher yields than wheat. Sugar beets, an important crop on this soil, yield from 10 to 21 tons, with an average of about 17 tons.

This soil has a rather dense, tight subsoil, and it is slowly permeable to water, especially when dry. The permeability appears to be greatly increased if the limy subsoil layer is not allowed to get too dry. This soil should be irrigated with care because of its relative impermeability. Careless use of water is probably responsible to some extent for the fact that about 5½ square miles of this soil that was formedly well drained is now waterlogged or in need of drainage and is classified as Taylorsville silty clay loam, poorly drained phase.

A small area—65 acres—near the highway 2½ miles west of Riverton has considerable gravel in the surface soil, and the subsoil below the carbonate layer is greenish gray. In sec. 29, T. 1 S., R. 1 W., southwest of Decker Pond, the surface soil contains some fine gravel and coarse sand.

A number of small areas occur that have a steeper topography than is typical. These are mostly arable but are inferior to the more level areas. Several long, narrow strips of this character, totaling about 95 acres, are on the east side of the valley, about 2½ miles east of Murray and extending north for about 2 miles. A tract including 23 acres is about 1½ miles north of Crystal Springs in sec. 1, T. 4 S., R. 1 W. On the west side of the valley there are two bodies totaling 55 acres, within a large body situated about 1 mile south of South Jordan.

Taylorsville silty clay loam, hardpan phase.—The hardpan phase is similar to typical Taylorsville silty clay loam except for the occurrence of a hardpan of travertine (limy material deposited from solution by mineral springs), in most places at a depth of 4½ to 5½ feet. The larger areas are about three-quarters of a mile southwest of Monroe School. A little more than 100 acres occur as a long, narrow strip adjacent to a large area of Churchill loam about 3½ miles west and 1 mile north of Taylorsville, just above and south of the Utah-Salt Lake Canal. This phase covers a total area of 512 acres.

Crop adaptations and yields are at present similar to those of Taylorsville loam, but owing to the impermeability of the hardpan material, care must be used in irrigation to avoid waterlogging of the soil.

Taylorsville silty clay loam, shallow phase (over Bingham soil material).—This soil is similar to typical Taylorsville silty clay loam but is rather shallow and is underlain by gravelly material similar to that of the Bingham soils. It is rather consistently brownish-gray

calcareous silty clay loam that generally contains a small quantity of gravel to a depth of about 3 feet or slightly less, below which is decidedly gravelly material. The upper part of the gravel is softly cemented by concentration of white lime carbonate, which in many places extends to a depth of 4 feet. Below the lime carbonate layer is a porous bed of coarse gravel. One small body in the NE¼ of sec. 31, T. 2 S., R. 1 W., of about 160 acres, and a body of about 50 acres in sec. 36, T. 2 S., R. 2 W., have a deeper surface soil than is typical, which in most places extends to a depth of 3 feet or more.

This shallow phase is well suited to dry farming and irrigation. It produces good yields of sugar beets, alfalfa, and small grains.

Taylorsville loam.—This soil is similar to Taylorsville silty clay loam except for the lighter texture of the surface layer. This surface layer, to an average depth of about 10 inches, is friable brownish-gray loam that generally has a good granular structure. Apparently this layer consists of an overwash of alluvial material over the silty and clayey lake-laid materials that compose the subsoil and the substratum. The subsurface layer, to a depth of about 15 inches, is slightly heavier in texture and more compact and overlies the layer of lime carbonate accumulation. The latter, which is light brownish-gray rather compact silty clay loam or silty clay mottled and streaked with white lime carbonate, extends to a depth of about 30 inches and is underlain by very light brownish-gray blocky or platy clay like that underlying Taylorsville silty clay loam.

This soil is fairly well distributed in the central part of the valley. Both with regard to the crops grown and the yields obtained, Taylorsville loam is similar to Taylorsville silty clay loam. The average yields for alfalfa and beets are somewhat lower on the loam than on the silty clay loam, whereas the yields of small grains are higher. The same minor crops that are grown on the silty clay loam are grown on this soil.

Several small tracts, totaling about 50 acres, that are somewhat eroded and are steeper than the typical Taylorsville loam, are included. One tract includes the steeper part of the long, narrow, irregular body southeast of Murray in sec. 16, T. 2 S., R. 1 E. A small body is about 2½ miles east of Murray and includes the western part of the small area south of the center of sec. 4, T. 2 S., R. 1 E. Care is needed to control erosion in such areas.

As mapped, Taylorsville loam includes a number of small areas that have a gravelly surface soil. Such areas are indicated on the soil map by gravel symbols. They have a total extent of about 1 square mile. Most of these areas occur adjacent to bodies of Taylorsville silty clay loam. They are rather widely distributed, generally in comparatively small areas, on both the east and west sides of the valley. A few variations of gravelly silty clay loam texture in secs. 20, 21, and 34, T. 1 S., R. 1 E., also northwest of the northwest corner of section 34, are included. These areas are nearly equal in value for general farming to those without gravel; the gravel, however, interferes somewhat with cultivation.

Taylorsville loamy fine sand.—This soil covers 1,088 acres. It occurs typically on the same terrace level as Taylorsville loam and Taylorsville silty clay loam, and it is all on the west side of the Jordan River.

This soil is similar to the other members of the Taylorsville series except that the surface soil, to a depth ranging from 8 to 12 inches, is a loamy fine sand with some variations ranging from loamy sand to fine sandy loam. The brownish-gray sandy surface soil probably represents an overwash or a wind-blown accumulation of material over the fine-textured old lake sediments. At an average depth of about 12 inches the material changes rather abruptly to light brownish-gray somewhat compact silty clay loam or clay, which extends to a depth of about 25 to 30 inches, where it becomes more definitely compact and finer in texture. In the lower part of this layer, at a depth of about 18 to 33 inches, occurs the main zone of lime accumulation, which is mottled and streaked with white lime carbonate. Below this lime carbonate layer and extending to a depth of about 48 inches is hard blocky or platy clay of very pale brown or reddish-gray color. The lower subsoil layer, between depths of 48 and 72 inches, is light-gray or pale-olive clay that contains many fine specks and splotches of rusty-brown iron oxide, indicating a formerly wet and poorly drained condition.

The surface soil when bare and dry is shifted by wind to some extent, and it also erodes more readily than the other soils of the Taylorsville series. With proper methods of cropping and irrigation, however, it produces good yields of sugar beets, alfalfa, wheat, oats, barley, and potatoes. In fact, farmers' estimates of yields indicate that this soil is almost as productive as Taylorsville loam or Taylorsville silty clay loam for those crops.

Near Chesterfield and Decker Pond, where the soils of the lake plain lie contiguous to those of the higher lying Taylorsville and Welby soils, there are small areas of poorly drained Taylorsville loamy fine sand. Except for the wetter condition in these small areas, the soil profile is typical of the Taylorsville series. Besides being wetter, the soil carries moderate or high concentrations of soluble salts, and such areas are therefore nonarable. They are utilized, however, as local farm pastures. The total extent of such tracts is about 80 acres.

Several irregular-shaped bodies of Taylorsville loamy fine sand about 1 mile west of South Jordan have a hummocky surface, and in these areas the sandy surface soil extends to greater depths than typical. When the hummocks are leveled and the land is irrigated, as is now being done, the soil is similar to the typical soil. The total area of these bodies of hummocky soil at the time the survey was made was about 60 acres.

PARLEYS SERIES

The Parleys soils occur on old alluvial fans or high-lying old lake terraces. The surface soils are brown or dark brown, the upper subsoil layers are brown with a slight red tinge in places, and the lower subsoil layers are pale brown, calcareous, and more or less mottled with white. These soils are somewhat similar to the Taylorsville soils but have a darker or browner color and a somewhat less mature development, with less pronounced concentration of lime in the subsoil.

Parleys loam.—This soil type has a pale-brown friable fine-textured loam or silt loam surface soil that is dark brown when moist. The upper subsoil layer is brown moderately compact silty clay loam, and the lower subsoil layer is paler brown silty clay loam faintly mottled with white lime carbonate. In places gravel beds lie within

6 feet of the surface. Bodies of Parleys loam occur north and east of the State Capitol and south of Fort Douglas. The total extent of this soil is 832 acres.

The areas included are under irrigation canals, and probably all have been used either for general farming or for fruit farming. At present the soil is being used partly for the production of fruit and partly for suburban residences or residence sites, and some areas are lying idle. General farming is practioed to only a minor extent.

The soil is well adapted to the production of general farm crops, such as alfalfa, small grains, sugar beets, corn, and potatoes. High yields of peaches, apricots, plums, and cherries are produced, and the fruit is of good quality.

Two areas, covering a total of about 95 acres, in which the surface soil is of fine sandy loam texture, are included with larger areas of this soil. The larger of these extends northwest of the center of sec. 16, T. 1 S., R. 1 E.; the other is in the SE¼ sec. 15, T. 1 S., R. 1 E. An area of about 40 acres located just north of the Utah Oil Refining Co. plant north of Salt Lake City is poorly drained and is used for industrial purposes.

Two small included areas, having an aggregate extent of about 45 acres, are of rougher relief and stony character. One of these areas, about 30 acres, in the south-central part of sec. 10, T. 1 S., R. 1 E., south of Fort Douglas, is stony, and an area of 15 acres in the northeast part of the same section is both rough and stony.

Parleys loam, gravelly phase.—This phase is similar to typical Parleys loam except that it contains a rather large quantity of gravel distributed through the soil profile. The total extent of this soil is only 384 acres, lying south of Fort Douglas. It is a less desirable soil for general farming than Parleys loam. The areas not used for homes or held as building lots are utilized for the production of fruit.

Parleys silty clay loam.—This soil is very similar to Parleys loam, but it has a finer or heavier textured surface soil and a somewhat heavier subsoil. In places it has a grayer and more distinct lime carbonate layer in the subsoil. Its present use and productive capacity are about the same as those of Parleys loam. There is slightly less than 400 acres of this soil, lying adjacent to Parleys loam, south of Fort Douglas.

AVON SERIES

The soils of the Avon series occur on high old lake terraces or alluvial fans. They are well drained at present but doubtless were once subject to poor drainage. The surface soils are medium dark brown and normally are not calcareous. The upper subsoil layer, between depths of about 5 and 15 inches below the surface, is coffee-brown compact clay with more or less distinct prismatic structure. Below this is a light-colored layer of high lime carbonate content, which grades into light yellowish-brown stratified material.

These soils occur in the southwestern part of the area. As mapped in this area they appear to be Solonetz or Solonetzlike soils.

Avon gravelly loam.—The surface soil of Avon gravelly loam is medium to dark-brown loam containing a rather large quantity of gravel. Fragments of gravel are scattered throughout the surface

soil and the subsoil, but the gravel does not occur in definite beds. The upper subsoil layer is brown prismatic clay, and the lower subsoil layer contains a large quantity of lime and considerable quantities of soluble salts. This soil occurs mainly north and east of Copperton. The total extent of Avon gravelly loam is 1,600 acres.

The topography varies considerably. The steeper areas are used largely for range land and are covered by a fair growth of common sagebrush, rabbitbrush, downy chess (cheatgrass), and a few species of bunchgrass, including slender wheatgrass and ricegrass. On some of the comparatively level areas the land is used for the production of dry-farmed wheat. This soil occurs in association with Bingham gravelly loam, and yields of dry-farmed wheat are very similar to yields obtained on the Bingham soil.

Small areas, having a total of about 240 acres, in which the soils contain comparatively little gravel, are included with Avon gravelly loam.

DECKER SERIES

The Decker series, which consists largely of imperfectly or poorly drained soils, is described on page 47.

Decker loam, well-drained phase.—This phase is similar in most characteristics to the typical Decker soils, but unlike those soils, it is well drained. Both surface drainage and subdrainage are good, and the ground-water level is more than 6 feet below the surface. The soil is free from injurious concentrations of soluble salts.

The surface layer, to a depth of about 10 inches, is medium to dark brownish-gray granular loam containing much coarse granitic sand or grit. The subsurface layer, to a depth of about 24 inches, is similar to the surface layer in color and general appearance but is slightly heavier in texture and more compact. The subsoil, to a depth of about 30 inches, is brown rather compact clay loam. The three layers described above contain little or no lime. The underlying stratified materials are light gray and limy, and they range from clay to sandy loam in texture but are mostly rather heavy and compact. They have a platy or blocky structure and are mottled or streaked with white lime carbonate and rust-brown iron oxide.

This is a productive soil, well suited to the production of a rather wide range of crops under irrigation. It is nearly all under cultivation. The more common crops are alfalfa, small grains, and sugar beets; and smaller acreages are used for potatoes, truck crops, corn, tree fruits, and irrigated pasture.

RED ROCK SERIES

The Red Rock series is the most extensive group of young soils that have little or no profile development. They occur on well-drained alluvial fans but include small areas of poorly drained phases. The surface soils are brownish gray or brown, well granulated and friable, and the subsoils are light brown or light brownish gray. No distinct layer of lime concentration occurs in these soils, but faint white mottlings or specks of lime carbonate are well distributed throughout the subsoil. The subsoils are permeable, allowing rather free penetration of water to a depth of 6 feet or more.

These soils are used mostly for general farming under irrigation. They are ideal for the growing of sugar beets, alfalfa, and the small grains.

Red Rock loam.—This is the predominant soil of the Red Rock series. The surface soil, to a depth of about 12 to 15 inches, ranges in color from brown to brownish gray, appearing dark brown when wet. It ranges in texture from loam to silt loam. Isolated boulders or stones occur in some localities in the surface soil and in other localities in the subsoil. With the exception of this feature and the slight variation in texture, the surface soil is unusually uniform. The subsoil, below a depth of 12 to 15 inches, is definitely lighter in color and contains carbonate of lime, which in many places occurs as a fine veining or in small well-distributed specks. The subsoil is permeable and friable loam, which absorbs water readily and retains it well.

For general farming under irrigation this is one of the best soils of the area. Farmers' estimates indicate that it is somewhat more productive than Taylorsville silty clay loam for alfalfa, wheat, oats, and barley, and slightly less productive for sugar beets. For the production of small grains under dry farming it is the best soil in the area. This soil has a wide distribution, but it is most extensive south and west of Riverton and near Herriman. Its total extent is 12.1 square miles.

In a few small bodies there is considerable variation in the character of the subsoil. Near Herriman occasional streaks of gravel occur in the subsoil material, but they are too irregular in occurrence for this variation to be indicated on the soil map. Small areas having a total extent of about 75 acres, 1¾ and 3 miles west of Riverton, in secs. 31 and 32, are underlain by stratified layers of gravel, sand, and loamy soil material. A number of small areas northwest of Salt Lake City, on the east side of the Jordan River, having a total area of about 120 acres, have a surface soil representative of Red Rock loam, which apparently has been deposited over material of the Logan series. The surface soil ranges in depth from 1 to 3 feet. It is light grayish-brown soft granular loam underlain by dark-gray clay loam or clay.

A few very small areas of a stony character, shown on the soil map by stone symbols, have been included with this soil in mapping. These appear to represent a recent overwash of stony material over the typical Red Rock loam. They are of very minor extent, there being only 65 acres in several small bodies in the southwestern part of the area. The stony variation of this soil is distinctly nonarable and can be used only as range land.

Red Rock clay loam.—This soil is similar to Red Rock loam in profile characteristics except for the heavier texture of the surface soil. The surface soil, to a depth of 12 to 15 inches, is dark grayish-brown clay loam with a soft crumb structure. Below this the soil becomes somewhat lighter in color, is slightly more compact, and contains fine mottlings of lime. The subsoil, which continues to a depth of 6 feet or more, is rather uniformly a clay loam that may be broken easily into soft irregular fragments.

This soil is associated with Red Rock loam but generally occupies somewhat lower positions. The total extent of this soil type is 2.1 square miles, all in the vicinity south of Riverton. The crops grown and the yields obtained are comparable to those given for Red Rock loam.

Red Rock silty clay loam.—This soil is heavier in texture than Red Rock loam in both surface soil and subsoil. In most places the silty clay loam surface soil extends to a depth of about 36 inches, but in some places to a depth of only 15 inches. Below this material the soil is generally stratified, the stratification consisting of layers of loam or sandy loam alternating with relatively thick layers of silty clay loam. This material, however, is fairly pervious and very retentive of moisture. The color ranges from grayish brown at the surface to light brown at a depth of about 36 inches. The subsoil below a depth of 36 inches becomes somewhat lighter in color with depth. Both surface soil and subsoil are calcareous. They are soft and friable, breaking into clods that are easily crushed. The upper part of the subsoil, which in general occurs between depths of 15 and 36 inches, contains fine mottlings or veinings of white lime carbonate.

Red Rock silty clay loam has a total area of 5 square miles, most of which is in the vicinity of Herriman and Riverton.

As mapped, Red Rock silty clay loam includes an area of 140 acres in which the surface soil is heavier—either heavy silty clay loam or silty clay. This area occurs in the northeastern part of sec. 9 and in the E½ sec. 4, T. 4 S., R. 1 W. An area of 65 acres in sec. 32, T. 3 S., R. 1 W., has considerable gravel in both the surface soil and the subsoil. This area is shown on the soil map by gravel symbols.

Nearly all of this soil is used for general farming under irrigation. Yields are approximately the same as for Red Rock loam. Estimates by farmers place Red Rock silty clay loam slightly above Red Rock loam for yields of sugar beets, wheat, and barley, and slightly below for alfalfa and oats.

Red Rock fine sandy loam.—This soil is friable fine sandy loam to a depth of 6 feet or more. The surface soil, to a depth of about 8 or 10 inches, is rather loose and in some places is subject to wind drifting when dry and unprotected by vegetation. Below this depth it is somewhat firmer and has definitely more body. In the areas of this soil east of the Jordan River the surface soil, to a depth of about 10 inches, is brown or light brown in color and is noncalcareous or only slightly so; whereas in the areas west of the river it is grayer and calcareous. Between depths of 10 and 24 inches the soil is slightly lighter colored and in most places slightly calcareous. The lower subsoil layer is light brown or light brownish gray and highly calcareous but otherwise uniform in character.

Several small areas of this soil occur near Salt Lake City. Larger bodies occur toward the eastern boundary of the area between Big Cottonwood and Mill Creeks and in and around Magna and South Jordan. The total extent of this soil is 2,368 acres, all of which is now used or has been used for irrigation farming.

Garden crops for home use are grown to some extent and do exceedingly well on this soil. Sugar beets, potatoes, wheat, barley, and oats are grown. Yields nearly equal the yields on Red Rock loam.

More frequent irrigation is essential than on the loam, however, as this soil has a lower moisture-holding capacity. Greater care must be used to control erosion and soil drifting.

As mapped in this area, small bodies having a gravelly surface soil occur in secs. 11 and 14, T. 2 S., R. 2 W., and in secs. 22, 23, and 14, T. 3 S., R. 2 W. A small area occurs in the southeast corner of sec. 20 and extends into the southwest corner of sec. 21, T. 3 S., R. 1 W., in which the material below a depth of 36 inches is very gravelly. These areas are somewhat less desirable than the typical soil.

There are a number of areas in Salt Lake City and vicinity in which the surface soil appears to be an overwash of Red Rock fine sandy loam over the darker colored Logan soils. The depth of the fine sandy loam overwash varies considerably from place to place but in general ranges from 1 to 3 feet. Below the grayish-brown surface soil the dark-gray Logan subsoil ranges in texture from clay loam to clay. The land is smooth and drainage is good, but there is a slight concentration of soluble salts in the subsoil. These areas are used mainly for the production of truck crops and for residential and industrial purposes.

A number of small, widely scattered areas east of the Jordan River, having a total extent of about 200 acres, have a lighter textured surface soil than is typical—loamy fine to medium sand. Such areas are somewhat less productive than the typical soil, and they require somewhat more frequent irrigation.

Red Rock gravelly loam.—In this soil the gravel is scattered throughout the entire soil profile and does not occur in the form of distinct beds. The soil is dark-brown loam in the surface soil but changes to brown loam in the subsoil. Both the surface soil and the subsoil contain a rather large quantity of gravel.

Except for the gravel, this soil is similar to Red Rock loam. Its value is somewhat less because of the gravel. It is used extensively, however, for general farming under irrigation. Yields of alfalfa, wheat, barley, and oats are definitely lower than on Red Rock loam.

This soil, of which there are 1,664 acres, occurs on gentle slopes at the foot of steeper slopes or as narrow bodies along the banks of washes and stream channels; otherwise its distribution is similar to that of Red Rock loam. In a few small bodies the surface soil and the subsoil contain stones. An area of 60 acres occurring largely in sec. 6, T. 4 S., R. 1 W., has a rolling relief.

ST. MARYS SERIES

The St. Marys soils have medium- or dark-brown friable surface soils that in the virgin condition are covered by a thin surface layer of partly decomposed leaves and organic materials and underlain by somewhat compact subsoils of pronounced reddish-brown or red color. The surface soils are leached of lime, and the subsoils are only feebly or irregularly calcareous in the lower part. These soils occupy high sloping alluvial fans and have developed on alluvial-fan materials having their source in red sandstones and brown shales. They support a cover of scrub oak and shrubs. They are inextensive and are represented in this survey by a single type of little agricultural significance, but this is distinctive and unlike other soils of the area sur-

veyed. The St. Marys soils appear to be immature and to owe their outstanding reddish-brown color to the parent rocks. The loam, mapped in this area, is most closely related to and is associated with the soils of the Parleys series.

St. Marys loam.—This soil, of which there is more than one-half square mile, occurs only in the area near St. Marys of the Wasatch School, just southeast of Fort Douglas. The soil material consists of wash from the red sandstone and brown shales of the mountains in that locality. This is a deep soil and has very slight compaction in the upper part of the subsoil. An area of about 50 acres immediately south of the school has a surface soil that is somewhat heavier in texture than is typical, ranging from loam to clay loam.

None of this soil is under cultivation. It is without a supply of water for irrigation, but most of it is fairly good arable land. The vegetation is largely oak brush growing in thick patches, with downy chess (cheatgrass) and snakeweed growing in the open spaces.

DRAPER SERIES

The soils of the Draper series are dark gray or brownish gray, becoming brownish black when wet. They are gritty soils derived largely from granitic alluvial material. The content of organic matter is comparatively high. The soils are rather coarse textured loams or sandy loams and contain little or no lime carbonate. They have little or no distinct profile but have many stratified layers.

Draper loam.—This is a dark brownish-gray loam containing a large quantity of coarse granitic grit. In places the dark color continues to a depth of almost 6 feet, but more commonly the material is lighter brownish gray below a depth of about 2 feet. In many places dark bands or layers occur in the subsoil. In most places the soil throughout is irregularly stratified with layers ranging in texture from coarse sand to gritty clay loam. Drainage is good, and the water-holding capacity is fair to good.

Draper loam occurs only in the southeastern part of the area. Its total extent is 832 acres.

Practically all of this soil is under cultivation and is used mainly for general farming. Some orchard fruits are produced. Farmers report excellent yields of canning peas, alfalfa, sugar beets, and small grains, where good farming methods are employed.

A number of small areas that have a slightly heavier textured surface soil than is typical occur south and east of the town of Draper. The total of these areas is about 25 acres. A body of about 10 acres of gravelly soil, at the mouth of Little Cottonwood Canyon, has been included with this soil type. Small areas of coarse gritty soil containing a large quantity of boulders and stone occur northeast of the mouth of Little Cottonwood Canyon. These are indicated on the soil map by stone symbols and have value only as grazing land.

Draper coarse sandy loam.—This soil is similar to Draper loam, but it has a coarser textured surface soil and typically a somewhat coarser textured subsoil. The surface soil is dark brownish-gray coarse sandy loam, and the subsoil is made up of irregularly stratified layers ranging from coarse sand to gritty clay loam in texture and from dark brownish gray to very light brownish gray in color. This

soil in general has a somewhat lower moisture-holding capacity than Draper loam.

This soil, which has a total aréa of 640 acres, occurs in rather small bodies associated with Draper loam. Most of the land is used for general farming, and some is in orchards. This soil is distinctly less productive than Draper loam, and it needs more frequent irrigation and liberal applications of manure if high yields are to be obtained. Under intensive cultivation it is adapted to tree fruits, small fruits, canning peas, and tomatoes.

An area of about 25 acres just east of Draper has a high groundwater level due to seepage from higher lying adjacent irrigated land.

WELL-DRAINED AND EXCESSIVELY DRAINED SOILS OF THE HIGHER ALLUVIAL FANS

The well-drained and excessively drained soils of the higher alluvial fans are underlain by sand and gravel. They are extensive and are used to a considerable extent for the growing of wheat under dry farming, and to a less extent for fruit growing and general farming under irrigation. Nearly all of them have a rather low water-holding capacity, and some are so coarse and porous that they are inferior for either irrigation or dry farming. The dry-farmed areas, consisting largely of Bingham soils, are somewhat difficult to work because of their content of gravel. They are fallowed in alternate years, and, although their moisture-holding capacity is low, they give fairly good yields in years of favorable rainfall. Under irrigation most of the soils of this group require frequent irrigation, and much water is likely to be lost by downward percolation. Uncultivated areas have some value as range for livestock.

This group of soils has three subgroups, as follows: (1) Mature (zonal) soils with limy subsoils, over beds of mixed gravel; (2) immature (azonal) soils with little or no lime in the subsoils, over beds of mixed gravel; and (3) immature (intrazonal) sandy soils with little or no lime in the subsoils, over granitic and quartzite sand or gravel. The first subgroup includes the Bingham and Churchill soils; the second, the Knutsen soils; and the third, the Wasatch soils.

BINGHAM SERIES

The Bingham soils have developed on alluvial fans of predominantly coarse, gravelly, or stony materials. The coarser material generally is noncalcareous, being derived mainly from the quartzites and igneous rocks of the Oquirrh Mountains and to a less extent from those of the Wasatch Range. The surface soils are brownish gray and generally contain considerable gravel. When moist they are dark brownish gray. At depths ranging from 1 foot to 2 feet below the surface is a layer of lime accumulation, in which the particles of gravel are generally coated with carbonate of lime and in places are more or less firmly cemented (pl. 3, *A*). The lime layer is underlain in most places at a depth of 3 to 4 feet by beds of gravel or gravelly sand.

As mapped in this survey, some of the soils included with the Bingham series on the east side of the valley have somewhat browner surface soils and browner somewhat heavier textured subsoils than are typical of the Bingham soils. These areas approach in character and

in small areas are almost identical with the Hyrum soils, which have been widely mapped in other areas in Idaho, Utah, and Wyoming.

The Bingham soils are used mostly for the production of winter wheat under dry farming, although some areas lie below irrigation canals and have been used for the production of alfalfa, grains, and tree fruits under irrigation (pl. 3, *B*). Water penetrates the lime carbonate layer slowly, and this may account, in part at least, for the fact that these soils produce fair yields of dry-farmed crops. Any water reaching the gravel layer below the lime carbonate layer is lost to the growing crop. Owing to the high porosity of the subsoils and a consequently low moisture-storage capacity, these soils are less desirable for irrigation farming than are the deeper, medium- to fine-textured soils of a number of other series in the area.

Bingham gravelly loam.—This is the most extensive soil type in the Salt Lake area. It has a total extent of 30.8 square miles. It occupies gravelly alluvial fans having gentle or moderate slopes and smooth to gently rolling relief. The largest areas are in the southwestern part of the valley on the fans at the foot of the Oquirrh Mountains. Drainage is good to excessive.

The surface soil, to an average depth of about 1 foot, is medium brownish-gray or dark brownish-gray mellow gravelly loam that breaks readily into granules or soft clods. The soil has an unusually high gravel content, ranging from 20 to 50 percent. The upper subsoil layer, to a depth of about 2 feet, is medium brownish-gray or dark brownish-gray gravelly loam mottled with white lime carbonate and having a coating of lime on the gravel particles. Between depths of 2 and 3 feet is a layer of light-gray or white lime-cemented gravel. The cementation typically is soft, although in some places thin layers of a firmly cemented hardpan resembling a conglomerate occur. The substratum consists of a porous bed of gravel and in some places contains streaks or layers of cemented gravel.

The greater part of Bingham gravelly loam is used for the production of winter wheat under dry-farming methods. Although the soil does not have sufficient depth to hold a large supply of moisture, the rainfall usually is sufficient and falls at the right time for the production of fairly good yields. In seasons when there is little rainfall in the spring, however, yields are comparatively low. Yields range from 9 to 25 bushels an acre. The average is probably about 16 bushels, although in the drier years the crop may be too light to justify harvesting it.

Under irrigation the soil is used mainly for the growing of small grains and alfalfa and to a minor extent for the production of orchard fruits and small fruits. Where proper irrigation methods are employed, this soil is well adapted to fruit production. The water requirement of the soil is high, frequent irrigation is necessary, and water is not used as efficiently as on deeper, fine-textured soils. The gravel that underlies the lime zone is of good quality for making concrete, and this is the reason for the large number of gravel pits in this soil. The gravel and the soil are used also for surfacing, filling, and grading roads.

Two small areas, totaling about 100 acres, in T. 2 S., R. 2 W., have a somewhat coarser textured surface soil than is typical. One small area of about 15 acres east of the center of T. 2 S., R. 1 E., is not so

A, Exposed section of Bingham soil, showing substratum of lime-encrusted and softly cemented gravel. *B*, Orchard on Bingham loam; peach trees on right, apple trees on left. Mill Creek Canyon in the distance. This is an important soil for general farming and fruit growing.

sandy loam. Two small bodies are on the east side of the valley, one about 1 mile south of Butlerville and the other 5 miles east of Murray in secs. 1 and 2, T. 2 S., R. 1 E. In secs. 4, 5, and 8, T. 3 S., R. 1 W., are additional areas with a total extent of 125 acres.

Bingham loam.—This soil is similar to Bingham gravelly loam except that the surface soil, to a depth of 6 or 8 inches, contains less gravel. The proportion of gravel in Bingham loam is probably everywhere less than 20 percent, ranging perhaps between 10 and 20 percent, with some included areas comparatively free from gravel in the surface soil. The separation of these two soils is solely on the basis of the gravel content of the surface soil. Bingham loam is a somewhat better soil, especially under irrigation, as there is less gravel to interfere with tillage implements. This soil is fairly extensive and fairly well distributed. It has a total extent of 4,672 acres, or 7.3 square miles.

An area of about 120 acres, immediately north of Granite Church, contains definitely less concentration of lime carbonate in the subsoil gravel, and the surface soil is darker brown.

In the area in the south half of sec. 35, T. 1 S., R. 1 E., there is a narrow strip through the southwest quarter of the section that has much steeper relief than is typical of this soil.

Important areas of this soil occur south of Fort Douglas and extend into the Mill Creek area, with a few scattered bodies extending south to the vicinity of Butlerville School. The soil in these areas is browner than typical in both surface soil and subsoil, and the upper subsoil layer is somewhat heavier and more compact. In the large area southwest of the mouth of Mill Creek Canyon both general farming and fruit growing are conducted under irrigation.

Some of the areas extending from a short distance south of Mill Creek north to the Fort Douglas Reservation and having an extent of about 400 acres have a somewhat thicker surface soil than is typical. These areas are somewhat better for crop production than the typical soil.

Bingham loam, deep phase.—This phase is similar to typical Bingham loam except that the lime layer and the gravelly substratum lie at a greater depth. This soil therefore has a thicker layer of the fine soil material and contains less gravel than does the typical Bingham loam. The surface soil is well granulated and does not change appreciably to a depth of 1½ to 3 feet, averaging about 2 feet. This soil differs from the deep phase of Bingham gravelly loam in having a smaller quantity of gravel above the lime layer. It produces well under irrigation when planted to sugar beets, alfalfa, and small grains, and it yields somewhat better grain crops under dry farming than does typical Bingham loam. Its total extent is 7.7 square miles, largely in the central part of the area.

In two areas of this soil the depth to the lime layer is more than 3 feet. One such body is half a mile west and 1 mile south of the Granger Latter-Day Saints Chapel. The other is about half a mile southwest of Monroe School in sec. 31, T. 1 S., R. 1 W. The soil in both of these localities has greater moisture-storage capacity and is more productive than the soil in the areas where the surface soil is shallower.

In three small included areas the surface soil is definitely coarser textured than a loam, because of the presence of very fine gravel or grit and a somewhat smaller proportion of the finer soil material.

One such body of about 30 acres is just south of the center of sec. 12, T. 2 S., R. 2 W., extending northwest into sec. 11, T. 2 S., R 2 W.; one of about 50 acres is in the SW¼ sec. 7, T. 3 S., R. 1 W.; and a third of about 30 acres occurs in sec. 35, T. 1 S., R. 1 E., and extends into sec. 2, T. 2 S., R. 1 E.

Bingham coarse sandy loam.—This soil type differs from Bingham loam only in the coarser texture of the 6- to 8-inch surface soil. The coarse material at and near the surface in this soil is rather uniform, the particles ranging from about 3 millimeters to slightly less than 1 millimeter in diameter. Coarser gravel, such as that in most of the Bingham soils, is absent. There is, however, less of the finer soil material, resulting in a somewhat more open and porous soil.

This soil occurs in a few small bodies in T. 2 S., R. 2 W., in secs. 2, 10, 15, and 22, and also in an area of about 5 acres in sec. 36, T. 1 S., R. 2 W. Most of the bodies are surrounded by areas of Bingham gravelly loam. The total area mapped is 1 square mile.

Most of this soil is used for growing wheat under dry farming. It is somewhat less productive than Bingham gravelly loam.

Bingham fine sandy loam.—This soil consists typically of fine sandy loam to a depth of about 8 to 10 inches. The surface soil in most places contains less than 20 percent of gravel. It is underlain by gravelly fine sandy loam extending to a depth of 12 to 24 inches. Below this layer and extending to a depth of about 30 to 36 inches is the lime carbonate and gravel layer that is typical of the Bingham soils. This material rests on gravel containing very little fine material.

This soil is most extensive in R. 1 W., Tps. 2 and 3 S., but there is only about 1½ square miles within the area. The land is used mainly for the production of winter wheat under dry farming; but as it is subject to some wind erosion, especially during the fallow year, it is somewhat less productive than Bingham gravelly loam.

Three areas, totaling about 250 acres, where the soil is of medium or coarse sandy loam texture, are included with this soil. One area lies to the east and south of the Riverton Cemetery, one is about half a mile farther south, and the third one is about 5 miles west of Bennion.

CHURCHILL SERIES

As mapped in the Salt Lake area, the Churchill soils are shallow soils, very similar to the Bingham soils. They are well drained and occur on alluvial fans in association with the Bingham soils. The chief feature distinguishing them from the Bingham soils is the layer of calcareous tufa or travertine capping the underlying gravel beds.

The surface soils are brownish gray, calcareous, and generally have a gritty or coarse sandy texture. The soils are fairly uniform above the light-gray calcareous tufa, which lies at a depth ranging from a few inches to 4 feet, probably averaging about 1½ feet. The tufa in most places lies over beds of boulders, cobbles, and gravel.

These soils have comparatively low water-holding capacity and generally give somewhat lower crop yields than the Bingham soils.

Churchill loam.—This soil type as mapped in this area ranges in texture from loam to clay loam, but it contains everywhere a considerable proportion of coarse gritty material. The surface soil is brownish gray when dry and brownish black when wet. It lies directly

over calcareous tufa, generally at a depth ranging from a few inches to about 2 feet, with an average depth of about 1 foot.

This soil is used mainly for general farming under irrigation. In areas where the tufa is within a few inches of the surface, crop yields are definitely low; but where it is a foot or more below the surface, yields in general are fair. The soil on the whole is considered rather poor arable land.

Churchill loam occurs entirely on the west side of the valley and is most extensive east of Magna and south of the Lincoln Highway. A number of small, scattered areas are near the foot of the mountains in the southern part of the area. The total extent is 2,496 acres. An area of about 225 acres, including the northern two-thirds of the area that occurs in sec. 34, T. 1 S., R. 2 W., is coarser textured than the typical soil.

A number of small areas, totaling about 60 acres, are steeper than is typical for most of the areas. These occur in the extreme southwestern part of the area in secs. 7, 8, 16, 17, and 21, T. 4 S., R. 1 W.

There are included with this soil a number of areas in which the calcareous tufa occurs below a depth of 1½ feet from the surface, and in a few places as much as 4 feet below. These areas are less droughty and produce better yields of grain and alfalfa than typical Churchill loam, and most of them are under cultivation. They have an aggregate area of about 420 acres and occur in association with the areas of shallow soil.

About 500 acres, occurring in scattered, irregular-shaped areas northeast and southeast of Copperton, contain considerable gravel. These are associated with Avon gravelly loam and Bingham gravelly loam and are used partly for the production of winter wheat under dry farming and partly for spring and fall range. Yields are probably somewhat lower than on Bingham gravelly loam.

KNUTSEN SERIES

The Knutsen soils are shallow, dark-colored soils overlying beds of loose gravel. The parent materials are alluvial-fan deposits derived largely from quartzite and associated metamorphic rocks, but in places they include some granite and limestone. The soils ordinarily are not distinctly calcareous.

These soils have low moisture-holding capacity and generally low productivity, although where they can be irrigated frequently they may be fairly productive for tree fruits, small fruits, and vegetables.

Knutsen gravelly loam.—This is an extremely shallow gravelly soil over porous beds of gravel. It occupies gently sloping but rather uneven and ridgy alluvial fans, mostly along Big Cottonwood Creek, Parleys Creek, and Mill Creek. Its total area is 2.6 square miles.

The surface soil, to an average depth of about 10 inches, is brownish-gray friable granular gravelly loam that is nearly black when wet. It lies directly over beds of gravel or gravelly sand that contain very little fine soil material. Neither the soil nor the underlying gravel is typically calcareous.

Much of this land is uncleared and has a cover of cottonwood trees, brush, grass, and weeds. Very little is under cultivation, and it is not desirable for the production of crops because of its droughty character. Much of it is in residential grounds, particularly in the Big Cottonwood district near Knutsens Corner.

As mapped this soil includes a number of small areas, totaling about 320 acres, in which the soil contains much stone as well as gravel. The surface is somewhat more uneven in these areas, which have value only as grazing land and residential property. These stony areas are indicated on the soil map by stone symbols.

Knutsen loam.—This is a friable brownish-gray or black loam, resting on beds of gravel, mainly of quartzite, together with a little dark-colored sandy material. This soil occurs along Big Cottonwood Creek, east of Butlerville School and north of Knutsens Corner, and along Mill Creek.

The areas in the Big Cottonwood district are finger-shaped bodies roughly paralleling the creek. Here the soil is noncalcareous and is used largely for suburban residences, home gardens, and orchards. In the Mill Creek locality the bodies are larger, and the soil is distinctly calcareous. Here the land is used for orchards, small fruits, and general farming. It is regarded as especially desirable for peach orchards.

This soil has low moisture-holding capacity and must be irrigated frequently in order to maintain favorable soil-moisture conditions for crops. The total extent is 896 acres.

WASATCH SERIES

The Wasatch soils are coarse-textured, porous soils that lie for the most part on high alluvial fans. Comparatively small areas are on low terraces along Little Cottonwood Creek. These soils are composed largely of granitic material with some admixture, in places, of material from quartzite and other rocks. The surface soils are friable or loose and yellowish brown or brownish gray and contain a moderate to rather small quantity of organic matter. The upper subsoil layers are brown or yellowish brown and firm and have a very slight accumulation of colloidal material coating the sand grains. The lower subsoil layers and the substrata are composed of loose sand and gravel. Typically, neither soil nor subsoil contains lime carbonate. These soils have low moisture-holding capacity and for the most part are excessively drained, although small areas, on account of their low position, have become affected by seepage from irrigation of higher land.

These soils are almost entirely on the east side of the valley, toward the southern end.

Wasatch coarse sandy loam.—This soil type has a total area of 8,064 acres. The surface soil, which averages about 1 foot in thickness, is somewhat variable in texture and in some places contains considerable fine or coarse gravel and stone, but it is typically a coarse sandy loam. It is of brownish-gray or weak-brown color when dry and dusky brown or brownish black when wet. It is underlain by brown material of similar texture. At a depth of about 2½ feet a loose sandy or gravelly substratum is reached. Typically neither the soil nor the underlying material contains lime carbonate.

Most of this soil lies on high alluvial fans above present sources of irrigation water. This fact, together with the low moisture-holding capacity of the soil and the consequent need for frequent irrigation if crops are to be grown, has largely prevented the development of farming on this soil. A small acreage east of Sandy is being used for general farming, and a number of small, scattered areas are in apple orchards

and vineyards. Yields of general farm crops as a rule are rather low, but orchard fruits and grapes appear to thrive where adequately irrigated and properly managed.

A large part of this soil is used for early spring range for livestock. The soil warms early in the spring, and downy chess (cheatgrass) makes a rapid and early growth. The native vegetation has been removed from most of the land, although a few tracts contain a scattered growth of short sagebrush and in a few localities there is a fairly vigorous growth of rabbitbrush.

Wasatch gravelly coarse sandy loam.—This soil is a loose, porous, coarse sandy loam that contains a large proportion of gravel and cobbles and rests on gravel beds. Small areas along Little Cottonwood Creek are composed largely of gravel and sand. This soil occupies slopes ranging from less than 2 to about 12 percent. North and east of Draper the soil occurs only on the steeper terrace fronts, but east of Sandy and around Union it occurs on both the steeper and the gentle slopes. The total area is 3.6 square miles. This soil has some value as range for livestock, but it is too coarse textured, gravelly, and stony to be valuable as arable land.

Wasatch sand.—This soil type consists of a few inches to 2 feet or more of brownish-gray medium or coarse sand over loose gray sand or gravel. In some areas the surface sand is underlain by a slightly loamy firm sand extending to a depth of 2 or 2½ feet, whereas in others it lies directly over loose gray sand or gravel. Because of the loose sandy and gravelly subsoil, the soil is excessively droughty. The vegetation consists mainly of downy chess (cheatgrass) and snakeweed.

This soil has a total extent of 2.1 square miles. The larger areas are north and east of Union and south of Butlerville School. A number of very small bodies and long, narrow strips are mostly north of the junction of Little Cottonwood Creek and the Jordan River.

This soil is generally not suitable for general farming. It is used largely for early spring grazing land. One body of 82 acres, about 1½ miles northwest of Granite Church, is coarser textured than typical Wasatch sand.

Wasatch loamy sand.—This soil lies on high alluvial fans in the vicinity of Granite Church and about 1 mile south of Butlerville School. Its total area is only 640 acres.

The 10-inch surface soil is typically dark brownish-gray loamy fine sand or loamy medium sand, although the texture ranges from sand to sandy loam. The subsoil, to a depth of about 3 feet, is yellowish-brown friable or loose material ranging from loamy sand to fine sandy loam. This rests on light-gray loose sandy material, which in some places is distinctly calcareous. The land typically is undulating to gently rolling and in some places is distinctly ridgy.

Probably not more than one-third of the area is under cultivation, no doubt because of the limited supply of irrigation water. The dominant vegetation is downy chess (cheatgrass), oak brush, and rabbitbrush. Farmers report that orchard fruits, such as peaches, pears, cherries, and apples, do exceptionally well on this soil where irrigated. The soil is also well adapted to the production of small fruits.

Wasatch sandy loam, shallow phase (over Welby soil material).—Typical Wasatch sandy loam does not occur in this area but is represented by a shallow phase of limited extent and importance.

Wasatch sandy loam, shallow phase (over Welby soil material), consists essentially of a porous sandy soil, in most places extending to a depth of 3 feet or more. It is similar in character to the Wasatch soils, but it has been superimposed over finer textured limy soil materials similar to those of the Welby series. The surface soil ranges in texture from loamy sand to medium or coarse sandy loam. Its color is generally pale brown but ranges from brownish gray to yellowish brown. It appears dusky brown when wet.

Beginning at a depth of approximately 10 inches and extending downward, the color gradually changes to light yellowish brown, and at a depth of 36 or more inches there is a light yellowish-gray or nearly white fairly compact lime carbonate zone. The soil above this zone is generally free of lime. That part of the soil profile between 10 and 36 inches is sandy loam or gritty loam, which, on exposure, breaks into clods that are fairly fine when dry but when slightly wet fall apart into a desirable crumb structure under very slight pressure. The deeper substratum in this soil is loose gray sand in some localities, whereas in others it consists of gray silty and clayey materials.

A number of small areas are included in which the surface soil is loamy sand. Among these are an area of about 25 acres about half a mile northeast of the junction of Redwood road and the Lincoln Highway; an isolated body of about the same size in the SE¼ of sec. 17, T. 2 S., R. 1 W.; an area of about 15 acres mainly in sec. 12, T. 2 S., R. 2 W.; a body of about 15 acres in secs. 33 and 34, T. 1 S., R. 2 W.; and one of 25 acres in sec. 14, T. 2 S., R. 1 W. About half a mile south of the mouth of Mill Creek Canyon there are a number of small bodies with a combined area of about 100 acres.

The total extent of this soil is 3.9 square miles. West of the Jordan River the land is used mainly for dry farming and is considered slightly more productive than Bingham gravelly loam. Little of this soil has been irrigated. Probably yields would be slightly less than on the coarser textured types of the Taylorsville and Welby series, as this soil has a lower moisture-holding capacity and probably is somewhat less fertile than the Taylorsville and Welby soils.

Wasatch loam.—This soil type is very much like Wasatch coarse sandy loam, but the surface soil has a higher content of fine material and a loamier texture. The surface soil is brownish-gray or weak-brown granular or soft-cloddy loam containing much gritty material. This layer extends to an average depth of about 9 inches and is underlain to a depth of about 18 inches by an extremely gravelly and cobbly loam. Below a depth of 18 inches is a loose, porous mass of gravel or gravelly sand. The soil is largely under cultivation, but it requires very frequent irrigation and its natural productivity is not high. It covers a total of 1,216 acres, most of which is northwest of Union.

A number of small areas of poorly drained soil, about 250 acres in total extent, have been included with Wasatch loam. Most of these occur along the course of Little Cottonwood Creek, northwest and southwest of Murray, and southeast of Sandy. These poorly drained areas are used largely for pasture.

IMPERFECTLY AND POORLY DRAINED SOILS OF THE BOTTOM LANDS AND OF THE LOWER AND FLATTER AREAS ON THE TERRACES AND ALLUVIAL FANS

The group of imperfectly and poorly drained soils of the bottom lands and of the lower and flatter areas on the terraces and alluvial fans includes a wide range of soils that have in common comparatively poor drainage, with a ground-water level generally within 6 feet of the surface. Although the soils have been called poorly drained, a considerable part of their total acreage is in reality only imperfectly drained and is capable of producing crops without artificial drainage. Some areas are too wet or too salty for cultivation, but probably most of them could be successfully drained and reclaimed. Considerable areas are now used for the production of pasture and wild hay, and some are highly prized for market gardening.

The group contains all the Logan and Gooch soils, the typical Decker soils, and poorly drained phases of the Welby, Taylorsville, Red Rock, Wasatch, Knutsen, and Draper soils. Poor drainage in these phases has been for the most part artificially induced by irrigation, whereas the Logan, Gooch, and most of the Decker soils probably are naturally imperfectly or poorly drained.

WELBY SERIES

The characteristics of soils of the Welby series have been described on page 22.

Welby loam, poorly drained phase.—This phase is identical with typical Welby loam except that through seepage from higher irrigated land or from careless use of irrigation water it has become more or less waterlogged and in some places impregnated with soluble salts. The approximate content of soluble salts is indicated on the alkali map for this area. Most of the areas are in reality imperfectly drained rather than poorly drained. They can still be cultivated, and good yields are being harvested. The crops grown and the yields obtained in those areas where the soluble salt content is low are comparable to those of typical Welby loam described on page 22.

This soil is confined largely to the district south of Salt Lake City in Tps. 1, 2, and 3 S., Rs. 1 E. and 1 W., and to a few scattered small areas west of Salt Lake City, north of Murray, and in vicinity of South Jordan. Its total extent is 4 square miles.

Some areas of this soil have a surface soil of heavy silt loam or silty clay loam rather than loam. They differ very little from typical Welby silty clay loam but have a comparatively high groundwater level.

It seems probable that most of the wetter and saltier areas of this soil could be reclaimed by artificial drainage and proper irrigation.

Welby fine sandy loam, poorly drained phase.—This phase consists of areas of Welby fine sandy loam that have a high water table due to seepage from higher irrigated lands. The soil generally contains measurable quantities of soluble salts, but seldom is the concentration sufficient to prohibit the use of the land for general farming. The areas of this poorly drained soil, of which there is a total extent of 1.2 square miles, are generally fairly productive, and the

yields compare favorably with those obtained from typical Welby fine sandy loam.

Several areas of this soil are west of United States Highways Nos. 50 and 91, locally called State Street, between Salt Lake City and Murray. Important bodies lie south of Midvale, and smaller bodies occur farther south in T. 3 S., R. 1 W., and T. 4 S., R. 1 W.

It seems probable that artificial drainage and washing out of excess salts would be feasible in most areas of this soil.

TAYLORSVILLE SERIES

The Taylorsville series has been described on page 25.

Taylorsville silty clay loam, poorly drained phase.—This phase is almost identical with typical Taylorsville silty clay loam except that it is less well drained. It lies somewhat lower than the typical soil, and, owing to seepage from higher irrigated land or to excessive irrigation, it has a high ground-water level—commonly within 6 feet of the surface—and in places has a comparatively high concentration of soluble salts. In most places no noticeable change has taken place in the soil on account of poor drainage.

Most areas of this soil can be plowed, cultivated, and used for the production of the common crops; some areas, however, are too wet or too salty to be suitable for crop production. A number of areas of wet and salty soils are west of the Jordan River and in the southeastern part of T. 1 S., R. 1 W. A large area of salty soil, largely uncultivated, lies along United States Highway No. 91 between Draper and the Jordan River. The latter area probably would be harder to drain and reclaim than most of this poorly drained soil.

The crops grown and yields obtained where the soil is comparatively low in soluble salts are comparable to or slightly lower than those obtained on typical Taylorsville silty clay loam. The wetter and saltier areas are inferior, and some of them are used only for pasture.

This soil covers a total area of 8.3 square miles. Most of it is in the south-central part of the valley.

Taylorsville silty clay loam, overwash phase.—The surface soil of the overwash phase of Taylorsville silty clay loam to a depth of a foot or more consists of dark brownish-gray clay loam or silty clay loam. It overlies a lighter colored clay subsoil, typical of the Taylorsville soils. The surface soil is derived from granitic material, similar to that in the Draper soils, which has been washed over the Taylorsville materials.

This soil occurs south and southwest of Draper and generally has a high water table. It is inextensive, occupying only 256 acres within the valley. It is devoted largely to pasture and to general farm crops and varies somewhat in productivity, depending on drainage conditions and content of soluble salts. Some of it could be improved by the installation of artificial drainage.

RED ROCK SERIES

The Red Rock series has been described on page 30.

Red Rock fine sandy loam, poorly drained phase.—The surface soil ranges in texture from gritty loam to fine sandy loam, and in color from brown to dark brownish gray. The subsoil, which is

from 1 to 2 feet below the surface, is somewhat lighter brown to a depth of 6 feet. The subsoil and the surface soil otherwise are very similar.

This soil is of limited extent, totaling only 1.2 square miles. It occurs in rather small areas on the bottom lands and low terraces along the present courses of Little Cottonwood Creek and Big Cottonwood Creek, a large part of the area being in the district near Murray and Union, northwest of Salt Lake City, and along the Jordan River. The water table is generally within a few feet of the surface, and in some areas a marshy condition exists. The soil in general is nonarable and is used largely as farm pastures in connection with nearby farm units. Much of it supports a good growth of pasture grasses.

Red Rock silty clay loam, poorly drained phase.—This phase is similar to typical Red Rock silty clay loam with the exception that the ground-water level is within 6 feet of the surface. As mapped, this soil occupies only a few isolated bodies with a combined area of 384 acres. Drainage is not seriously impaired in the surface soil and the upper subsoil layer. Farming operations are carried on without inconvenience, and most areas of this soil are only slightly less productive than typical Red Rock silty clay loam. One large area is north of Magna. Several bodies are in the vicinity of West Jordan School and South Jordan.

WASATCH SERIES

A description of the Wasatch series appears on page 41.

Wasatch coarse sandy loam, poorly drained phase.—This phase is similar to typical Wasatch coarse sandy loam, but because of its position it has become affected by seepage from higher land. The total extent of this soil is 1,216 acres. It occurs as small, irregular-shaped patches in association with typical Wasatch coarse sandy loam, mostly to the south and east of Sandy. This soil is used principally for farm pastures. Areas of poorly drained Wasatch sand totaling about 100 acres are included.

A number of small areas along Little Cottonwood Creek consisting of loose sandy and gravelly material have been included with this soil. They are not so well drained as typical Wasatch coarse sandy loam, and low-lying areas may at times be subject to overflow. They cover a total area of about 400 acres and are used mainly for pasture.

Wasatch sandy loam, shallow poorly drained phase (over Welby soil material).—This soil is similar to Wasatch sandy loam, shallow phase, except that it occurs in slightly depressed areas and the water table stands within 6 feet of the surface. It is not extensive, having a total area of only 1 square mile. This soil is used mainly for pasture in connection with local farm units. It is distributed in rather small areas near Murray and in the vicinity of Sandy.

KNUTSEN SERIES

The Knutsen series is described on page 40.

Knutsen loam, poorly drained phase.—This phase has a water table within a few feet of the surface, and in many places a marshy condition exists. This soil occurs in a number of small patches

adjacent to bodies of typical Knutsen loam, almost entirely in T. 2 S., R. 1 E. There are 320 acres, used mainly for pasture.

This soil is a shallow soil over gravel, very similar to typical Knutsen loam. Drainage probably would be fairly easy, but the soil if drained would have rather low moisture-holding capacity and would require frequent irrigation.

DRAPER SERIES

The Draper series is described on page 34.

Draper loam, poorly drained phase.—This phase is similar to typical Draper loam, but it has been subjected to seepage from irrigation and has a water table within 6 feet of the surface. The surface soil and the subsoil are distinctly calcareous, and in a number of places the soil contains small quantities of soluble salts. Most of this soil occurs near Draper, and most of it is under cultivation. As a general rule farmers have provided some drainage facilities, but they report that the present drains have not proved adequate.

The crops most successfully grown are sugar beets and small grains. Young stands of alfalfa produce well, but alfalfa soon dies out, owing to the high ground-water level. Part of this land is used for pasture, for which it is well suited.

Draper loam, shallow phase (over Taylorsville soil material).—This soil has a dark-colored gritty loam surface soil, representing material of the Draper series and ranging from 1 to 3 feet in thickness. It overlies light-gray, highly calcareous silty and clayey old lake deposits similar to those underlying the Taylorsville soils. The soil is typically rather poorly drained and commonly contains small or moderate quantities of soluble salts. It is used largely for pasture and to a smaller extent for general farm crops. It is somewhat less productive than typical Draper loam. A number of small areas are near the town of Draper, mainly south and immediately west. The total extent of this soil is 192 acres.

DECKER SERIES

The Decker soils occur mostly in the northern part of the area. They are most extensive on low terraces a short distance from the banks of the Jordan River where that river enters the lake plain. The surface soils range from brownish gray to dark brownish gray in color and contain considerable quantities of medium and coarse sand and fine gravel. This surface layer represents an overwash over gray tight lake-laid silts and clays. These soils typically have a high water table and contain considerable quantities of soluble salts, although the well-drained phase of Decker loam is both well drained and practically free from soluble salts.

Decker loam.—The surface soil to a depth of 20 to 24 inches is brownish-gray or weak-brown loam, which in some places is of gritty texture. The subsoil from this depth to a depth of 50 to 60 inches is friable loam or sandy loam, below which is light-gray heavy tight calcareous clay. This soil is commonly poorly drained or imperfectly drained; but where drainage is possible and has been provided, and where the soil is properly irrigated, satisfactory yields of general farm crops are obtained. The surface soil is generally heavy loam, but it ranges from loam to clay loam.

A body of about 15 acres with a sandy subsoil occurs along the section line largely in the NE¼ sec. 15, T. 1 S., R. 1 W. Two small areas about 1 mile northeast of Sandy have a surface soil that is slightly lighter in texture than is typical. A long, narrow body of about 23 acres, northeast of Murray in section 5, is somewhat steeper but was included with this soil.

This soil occurs mostly on low terraces near the Jordan River or close to old stream courses, slightly above the general level of the nearly flat lake plain. The total extent is 3.6 square miles.

Fairly good yields of sugar beets, small grains, and alfalfa are obtained on the less poorly drained areas. The particularly well drained areas are mapped as Decker loam, well-drained phase, described on page 30.

Decker sandy loam.—The surface soil ranges from gritty loam to medium sandy loam; otherwise it is similar to Decker loam. The soil is typically poorly drained.

Included in this soil is one area of about 8 acres of stony sandy loam lying southeast of the center of sec. 22, T. 1 S., R. 1 W., and also an area of 28 acres in sec. 10, T. 1 S., R. 1 W., which has a coarser subsoil.

This soil, of which there is a total area of 2.3 square miles, is largely on the low terrace west of the lower Jordan River on the eastern edge of the lake plain. Much of the area included in Decker loam and Decker sandy loam has been farmed at one time, but a large part of it has been abandoned because of unfavorable drainage and salt concentration. The present vegetative cover consists of downy chess (cheatgrass), saltgrass, and a mixture of rabbitbrush and greasewood.

LOGAN SERIES

The Logan soils have gray, dark-gray, or brownish-gray surface soils, appearing nearly black when wet, and subsoils of light-gray or light olive-gray color, with pale-orange layers in some places. Bands of dark-gray clay or of somewhat coarser materials are present in the subsoil in many places. These soils occur typically on poorly drained bottom lands, particularly of the Jordan River (pl. 2) and its main tributaries. Some included soils are on low nearly flat alluvial fans. Both surface soils and subsoils are highly calcareous in most areas. The soils are typically poorly drained, and many areas are wet at the surface for at least a part of each year. In the wetter areas there is a vigorous growth of sedges, saltgrass, foxtail, redtop, and ticklegrass, among other water-loving species, and where the water table lies at a somewhat greater depth the vegetation consists principally of bushy atriplex, samphire, and other salt-tolerant plants. Because the soils of this series are distributed in small or long narrow areas throughout the center of the entire valley, and because they occur in low-lying, wet localities, the land is used primarily for pasture, much of which is irrigated. Native grasses are most common, although clover, alfalfa, and tame grasses are used to some extent and appear to do well in some places (pl. 2). Small areas are used for the production of celery and other truck crops.

The alluvial-fan phases of the Logan soils are better drained than the typical soils, contain less salts, and are highly productive for truck

crops, sugar beets, and general farm crops, although alfalfa is short-lived when grown on these soils.

Logan clay.—This is the most extensive soil of the Logan series It generally occurs on the bottom lands along the present courses of the Jordan River and its two tributaries, Big Cottonwood and Little Cottonwood Creeks. It is a dark-gray clay, nearly black when wet, to a depth ranging from about 1 to 3 feet. In some places the subsoil is stratified, but it is essentially heavy—in most places clay loam, silty clay loam, or clay. Below the dark-colored surface soil the material is light gray and marly, and still lower it is light olive gray, in most places highly mottled with rusty iron stains and generally high in lime carbonate. This soil occurs along both banks of the Jordan River for a distance of about 28 miles, in small areas or in long, narrow bands, most of them less than a half mile in width. The land is typically poorly drained, and many areas are wet at the surface for a time during each year.

In the wetter areas there is a growth of sedges, tules, and other water-loving plants. In some of the larger areas of this soil, especially those near the foot of the bluff separating the bottom land from the higher terrace, the water table has been raised by seepage from the higher land, and here injurious accumulations of salts occur. Many such areas support a growth of saltgrass, greasewood, or bushy atriplex. This soil cuts through the main cultivated part of the valley and is used primarily as pasture, although very limited areas are used for truck gardening and to a minor extent for general farming. Celery is the principal truck crop and does well where the land is properly irrigated and manured.

The aggregate extent of Logan clay is 8.7 square miles. The subsoil is generally heavy, but in some areas open sandy subsoil materials occur. This variation, totaling about 160 acres, is made up of a number of small areas along the Jordan River in T. 1 S., R. 1 W.

Logan silty clay loam.—This soil type is similar to Logan clay but is somewhat lighter in color and of lighter, silty texture. The surface soil is typically silty clay loam, but variations are included that range in texture from heavy loam to clay, with color variations from light mouse gray to light olive gray. In most places the subsoil ranges from heavy loam to clay. The lower part of the subsurface is slightly less dark than the surface soil, and the lower part of the subsoil has a definite green tint.

This soil is typically poorly drained and is generally used only for pasture, some of which is irrigated. Most of it is marginal or non-arable. It occurs in small isolated areas or in long, narrow strips near the Jordan River and Big Cottonwood and Little Cottonwood Creeks. As with Logan clay, some of the areas have been subject to overflow during periods of high water. The total area of this soil is 6.6 square miles.

A number of variations of Logan silty clay loam are included. The silty clay loam surface soil occurs as an overwash on clay in a number of small areas, scattered along the Jordan River, with a total of about 100 acres. A body of about 45 acres, unusual in that it is distant from streams, occurs in secs. 25 and 26, T. 1 S., R. 2 W. This area, however, is typical of Logan silty clay loam.

A local variation having a coarse-textured, open, porous subsoil occurs in small areas totaling about 140 acres, mostly in the northern part of the valley. The subsoil in all these areas, from a depth ranging from about 15 inches to 6 feet, is unusually coarse textured and ranges from coarse loam to sand.

A few very small areas widely scattered along the Jordan River have a ground-water table within a foot and a half of the surface, and they may be completely saturated at the surface.

Logan silty clay loam, alluvial-fan phase.—This soil is similar to typical Logan silty clay loam, but it lies on very gently sloping alluvial fans and is better drained and freer from soluble salts. The surface soil is typically smooth silty clay loam, although it is silty clay in places. The soil to a depth of about 2 feet is brownish gray, appearing nearly black when moist. Below a depth of 2 feet the soil is of heavy texture and of light-gray, brownish-gray, or pale-brown color. Parent soil materials are derived from quartzite and limestone rocks.

Both surface soil and subsoil are distinctly calcareous. The surface soil has a rather unusual amount of organic matter for soils of this area and is well granulated and friable. The total extent of this soil is 2.5 square miles. It occurs on rather smooth very gently sloping alluvial fans and bottom lands south and east of the main business district of Salt Lake City and north and slightly east of Murray. Owing to its occurrence in low-lying positions, it has a high ground-water level with free water within 6 feet of the surface. The soil is comparatively free from soluble salts. With ordinary care in irrigation, truck gardening is carried on successfully.

Practically all of this soil is good-quality arable land, although a large part of it is now used as sites for suburban and city residences. It is especially well adapted to the production of celery and produces good yields of sweet corn, asparagus, and other truck-garden crops.

Logan loam.—Where typically developed, the surface soil is dark-gray or nearly black loam to a depth ranging from a few inches to a foot. The subsoil is light gray and highly calcareous, and the lower part is mottled or variegated gray and rusty brown, in some places containing pinkish-brown layers. This soil in general is poorly drained and more or less affected by accumulations of salts. The total extent of the typical areas is 7.7 square miles, located principally west of Salt Lake City, although a few areas are near Murray.

Some of the land is used for pasture, some for industrial purposes, and some areas have been drained and are used for the production of truck crops.

Two small areas, totaling about 15 acres, were recognized as representing an overwash of Logan loam over Logan clay. One area is in sec. 25, T. 1 N., R. 1 W., and the other occurs as a narrow strip on the east side of the river in sec. 14, T. 2 S., R. 1 W.

Some areas of Logan loam have a lighter gray surface soil and a lower content of organic matter than is typical. Approximately one-half of a square mile of land of this character is located in the extreme northern part of the area, northwest of Salt Lake City. One area on the east side of the Jordan River in sec. 14, T. 2 S., R. 1 W., contains considerable gravel below a depth of 30 inches.

A heavy-textured inclusion of Logan loam has a total area of about three-fourths of a square mile. This soil is similar to typical Logan

loam except for the slightly heavy texture of the surface soil. It occurs in small areas along Big Cottonwood Creek, Little Cottonwood Creek, and the Jordan River, north of the junction of the two creeks with the river, and in low areas along United States Highways Nos. 50 and 91, locally called State Street, north of Murray, and also west and north of the business district of Salt Lake City. The areas are poorly drained, with a water table within 4 feet of the surface. They generally produce a growth of saltgrass, downy chess (cheatgrass), and shepherds-purse.

Another inclusion of Logan loam is identical with typical Logan loam in surface soil, but it is underlain at a depth of 1 to 3 feet by tough, tight, dense, highly calcareous clay, which is comparatively impermeable to water and is of hardpanlike character. This inclusion has an area of about 1 square mile and occurs along the Jordan River north of Twenty-first South Street in Salt Lake City.

Logan loam, alluvial-fan phase.—This soil is associated with the alluvial-fan phase of Logan silty clay loam, south and east of the business district of Salt Lake City. The two soils are alike except that this phase of the Logan loam has a gritty texture and carries some gravel in the surface soil. It has a total area of 1.8 square miles. It is an excellent soil, and its use and productive capacity are practically the same as those of the alluvial-fan phase of Logan silty clay loam.

GOOCH SERIES

The Gooch soils are light brownish-gray, light-gray, or medium-gray poorly drained soils over marly, lime-cemented hardpan and calcareous tufaceous deposits from mineral springs or precipitated from upward moving ground water. The soils are poorly drained, are generally highly charged with soluble salts, and are of little value except for pasture.

Gooch clay loam.—The surface soil is brownish-gray or gray clay loam to a depth of a few inches. The subsoil is granular and is light gray or in places light olive gray, yellowish gray, or very pale orange. A lime-cemented hardpan or calcareous tufa occurs in most places at a depth ranging from 1 to 3 feet. In some places this is too hard to be pierced with the soil auger, although in other localities it is comparatively soft. Drainage is very poor, and the salt content is high. Saltgrass and sedges form the principal vegetative cover.

This soil occurs mostly northwest of the Garfield smelter plant and in the southern part of the area, in the vicinity of Crystal Hot Springs. It is not extensive. It is used almost entirely for pasture, for which it has medium to low value.

In the vicinity of Utah Copper Lake, in secs. 24, 25, and 26, T. 1 S., R. 2 W., the surface soil, to a depth of about 36 inches, varies from a reddish-gray to pale-orange granular clay. Here the hardpan occurs at a depth of about 36 inches and breaks readily to a crumbly consistence. In small local areas in this vicinity the hardpan is reddish brown and granular, but it is soft enough to be broken with an auger. Below the hardpan is heavy gray clay highly mottled with black, red, and yellow. About 200 acres is the extent of this variation.

Gooch loam.—This is a light-gray or medium-gray loam over calcareous tufa. It is very similar to Gooch clay loam but has a lighter,

grittier texture. It occurs principally adjacent to areas of Gooch clay loam, and the vegetative cover and land use of the two soils are practically identical. It is used principally for pasture, which has a medium to low carrying capacity for livestock.

The total extent of Gooch loam is 1,280 acres. Three bodies with a total extent of about 140 acres have a sandy loam surface soil. One area is in secs. 25 and 36, T. 1 N., R. 3 W., and two of them parallel the shore of the Great Salt Lake, about 1 mile east of the shore line, in secs. 9, 10, and 16, T. 1 S., R. 3 W. About 200 acres south of Utah Copper Lake have a higher water table than the average.

Gooch loam also includes a variation having a very thin dark surface soil and a subsoil containing a very high percentage of white or yellow mealy gypsum and lime carbonate. The lower subsoil layers are cemented and apparently consist of a mixture of gypsum and lime carbonate. The dark surface soil extends to a depth of only 1 or 2 inches and rests directly on the gypsum material. This variation occupies an area of approximately 200 acres, lying north of the main business district of Salt Lake City in secs. 23 and 26, T. 1 N., R. 1 W. It is distinctly nonarable and has very low value as pasture land. The dominant vegetation is pickleweed.

POORLY DRAINED SALTY SOILS OF THE LAKE PLAIN

The poorly drained salty soils of the lake plain occupy the extensive comparatively flat area between Salt Lake City and the Great Salt Lake. These soils have a high ground-water level and with minor exceptions contain excessive quantities of salts. Attempts have been made to farm these soils, but as most of the once-cultivated areas have been abandoned, probably most of the land should be considered nonarable. Much of the land is used for various commercial, industrial, and recreational purposes, including an airport; salt works with evaporating basins; dumping grounds for slag, tailings, and various industrial wastes; game and bird preserves; gun clubs; and muskrat farms. Large areas are used as livestock range but have low carrying capacity.

This group includes the Airport, Terminal, and Saltair soils.

AIRPORT SERIES

The Airport soils occur on the lake plain. The land is smooth and nearly flat, and in general the soils have a high concentration of soluble salts and a high ground-water level.

The surface soils are light gray or brownish gray, and the subsoils have a light-gray well-developed zone of lime carbonate overlying stratified lake-laid materials of dominantly fine texture. These soils are generally decidedly nonarable and can be used for agricultural purposes only as early spring or late fall and winter range for livestock.

Airport loam.—Typical Airport loam is light-gray or brownish-gray loam to a depth of 6 to 10 inches. This is underlain by a light-gray clay, in which a well-developed zone of lime concentration occurs at a depth of 1 or 2 feet. The surface soil generally contains high concentrations of soluble salts and is typically poorly drained. The texture of the subsoil typically ranges from clay loam to clay, although in some places it is stratified with sandier materials. The lower part of the subsoil commonly is light gray with rust-brown mottling, but in places it includes layers of yellowish-gray, light olive-gray, reddish-gray, and

pale-orange material. Airport loam in some places has within the lime-concentration zone a hardpan of variable thickness. The occurrence of the hardpan is very irregular, and its depth from the surface varies. An important characteristic of this soil is its nearly level surface, which may account for the fact that a large part of it has at some time been cultivated. A high concentration of soluble salts and a high water table probably account for past failures in farming. The land has some value, however, as grazing land for both cattle and sheep, particularly in the fall and spring.

Airport loam, of which there is a total extent of 22.5 square miles, supports a rather sparse covering of greasewood, bunchgrass, and downy chess (cheatgrass). In some small areas the water table stands within a few inches of the surface, but the height varies with the season and perhaps with other conditions, and it was impossible to separate the wetter areas on the map.

As mapped, Airport loam includes a number of variations in texture of surface soil and subsoil materials. In some areas the surface soil is brownish-gray gritty loam or fine sandy loam resting directly on gray clay. The lower part of the subsoil, generally at a depth ranging from 4 to 6 feet, contains somewhat more sand and is more open than the upper part. In approximately half of the total area of this inclusion, which occupies about 500 acres, the water table ranges from a few inches to 2 feet from the surface, and in the entire area it is well above the 6-foot level. This soil is associated with other areas of the Airport soils, particularly in the southern part of T. 1 N. and the northern part of T. 1 S., Rs. 1 and 2 W.

Other included areas have coarser and lighter textured subsoil materials. In such areas the surface soil and the upper part of the subsoil are similar to those of the typical Airport loam to a depth of about 30 inches, below which the material is decidedly coarse in texture. In many places there is a layer of sand, more than 2 feet thick, between depths of 30 and 60 inches. A few of these areas have a water table within a few inches of the surface.

Some areas have a deeper subsoil that is intermediate between that of the typical Airport loam and the areas with a light-textured subsoil; that is, the lower part of the subsoil is stratified but is dominantly medium textured and fairly permeable.

A few areas in secs. 21, 29, and 32, T. 1 N., R. 1 W., and in sec. 18 T. 1 S., R. 1 W., have a surface soil of heavy loam or silty clay loam texture, underlain by a subsoil of intermediate texture. One area of about 100 acres, with a rough or billowy surface, occurs in sec. 19, T. 1 S., R. 1 W., and in the east-central part of sec. 24, T. 1 S., R. 2 W. Several small areas are included in which the surface soil is of silt loam texture, but they conform to typical Airport loam in profile, drainage, and other characteristics.

Airport loam, deep phase.—This phase represents the better areas of Airport loam. Friable soil in places extends to a depth of 3 to 3½ feet, below which is light olive-gray clay. In some localities stratified layers ranging from sand to clay occur between 60 and 72 inches. In all places, however, the clay predominates and the sand layers are thin. The total extent of this soil is 1.1 square miles. The land is used to some extent for general farming, where artificial drainage has been provided, but it is used more commonly for pasture. The native vegetation consists of rabbitbrush, greasewood, and bunchgrasses.

TERMINAL SERIES

The Terminal soils occupy low nearly flat lake plains, which in geologically recent times have been covered by the waters of the Great Salt Lake. The soils have a high water table, a high content of soluble salts, and in general a well-developed claypan with prismatic or columnar structure that in places is of typical Solonetzlike character. In many places a lime hardpan occurs below the claypan. In most places the hardpan is only a few inches thick and is platy and of intermittent occurrence.

Terminal loam.—This soil type has a light-gray or light brownish-gray surface soil to a depth ranging from 3 to 10 inches, below which it changes abruptly to coffee-brown prismatic or columnar clay with characteristic rounded-top columns. The coffee-brown columnar layer gradually gives way below to a light-gray or nearly white high lime carbonate concentration, within which is developed a platelike lime-cemented hardpan. This hardpan is of irregular occurrence and varies considerably in thickness as well as in depth from the surface. In some places two distinct hardpan layers are present, with light olive-gray clay between them. The lower subsoil layer is tough clay that is either light gray with a definite olive tint, pale brown, or pale orange.

Rather pronounced variations in the hardpan were observed in two localities. In secs. 6 and 7, T. 1 S., R. 1 W., the hardpan is firmer, of greater thickness, and continuous in an area of approximately 125 acres. The second area, the total extent of which is 1¼ square miles, occurs near the southeast shore of Utah Copper Lake. Here the hardpan is within 10 or 12 inches of the surface and is generally wet and somewhat porous.

Terminal loam is confined almost exclusively to the lake plain west of Salt Lake City. In most places the surface is nearly level and smooth, although a few small areas are hummocky or billowy. This soil is poorly drained, and in some places the water table stands within 18 inches of the surface. The soil carries moderate, strong, or excessive concentrations of soluble salts, and with minor exceptions it is nonarable. Where it is contiguous to arable soils it sometimes serves as farm pasture, but its most general use is for spring and fall grazing for range livestock and to a limited extent for muskrat farming. Some use is made of it as dumping grounds for waste products from industrial plants.

Most of this soil supports a vegetative cover characteristic of soils impregnated with an excess of soluble salts. Small areas within it are barren and have a tight, hard surface soil. Generally, however, the surface soil to a depth of 3 to 6 inches is well granulated. Greasewood of moderate height, but widely scattered, and downy chess (cheatgrass) form the common vegetative cover, but there are small areas covered with bunchgrass, and in the slightly depressed areas there is a growth of small, bushy *Atriplex* species. Attempts have been made to farm tracts of this soil, but these have been unsuccessful. This is one of the most extensive soils in the Salt Lake area; it covers 28.3 square miles.

An area west of Utah Copper Lake in secs. 23 and 24, T. 1. S., R. 2 W., that departs widely from typical Terminal loam, has been included with this soil. Here the surface soil and subsoil materials

are of lighter texture, and the columnar Solonetzlike structure is wanting or only feebly developed. The surface soil is fine sandy loam to a depth ranging from 24 to 36 inches, and below this is wet gray coarse sandy loam extending to a depth of 72 inches or more. In general, the land is gently rolling or hummocky. In small areas of this soil the hummocks have been leveled and general farming is successfully conducted. A limited area lying somewhat higher than the surrounding areas is better drained.

Terminal silty clay loam.—This is one of the more extensive soils of the lake plain west of Salt Lake City. Its total area is 10.9 square miles. The water table stands within 6 feet of the surface in most places, and in many places within 2 feet. The soil contains large quantities of soluble salts.

The surface soil is shallow, in most places only 3 or 4 inches thick. It consists of light-gray or brownish-gray heavy silt loam or silty clay loam. In most places it is friable and granular, but in spots it is badly puddled, baked, and hard. Such spots either are barren or have a very scant brush and grass cover. Below the thin surface soil is a brown claypan, a few inches thick, which in most places has a prismatic or columnar structure. The claypan is underlain at a depth of about 1 foot by light-gray clay containing a layer or layers of lime-cemented hardpan. The material below the 2-foot depth consists of light-gray, light olive-gray, and pale-orange tough blocky clay, which continues to a depth of 6 feet or more.

This soil in most places cannot be used successfully for the production of crops under present conditions, but it has some value for grazing. As in Terminal loam, the surface is nearly level in most places, but a few small areas having an undulating surface are included. The native vegetation consists of a rather sparse growth of greasewood, downy chess (cheatgrass), bunchgrass, and bushy atriplex.

SALTAIR SERIES

The soils of the Saltair series are generally light-gray or light olive-gray clays without distinctly developed layers. They are heavily impregnated with soluble salts. They occur chiefly in low depressions or playas on the plain bordering the Great Salt Lake. In a number of isolated areas there is considerable organic matter in the thin surface soil, which is dark gray when dry and black when wet. The subsoil is typically heavy clay, commonly stratified and ranging in color from pale brown or pale orange to light olive gray mottled with rusty brown. In a few areas rather coarse gray sand is present. All these soils are poorly drained, high in content of salts, nonarable, and for the most part barren. The native plants invading these playa areas include samphire, pickleweed, and seepweed.

Saltair clay.—This soil type occupies the playa areas in the northwestern part of the area adjacent to the Great Salt Lake (pl. 4, *A*). The surface soil, to a depth of about a foot, in most places is light-gray or light olive-gray sticky wet clay. The subsurface soil and the subsoil are pale-brown, pale-orange, and light olive-gray stratified clay. In most places the soil is barren of vegetation, but in a number of localities marshy areas produce tules, sedges, and saltgrass. Areas of this soil total 32.2 square miles in the Salt Lake area. In a few localities the thick clay subsoil is broken or interrupted by thin strata of

sandy material. Such bodies are situated so low that the more permeable sandy materials can serve no purpose for drainage.

Saltair clay, mucky phase.—The mucky phase of Saltair clay has a dark-gray surface soil of high organic content, ranging in thickness from 3 inches to a foot or more but probably averaging 6 inches or slightly less. Otherwise it is typical of Saltair clay. This soil has developed in low playas where the surface has been sufficiently wet to remove the excess of soluble salts and thereby allow the growth of a marsh vegetation including tules, sedges, and other water-tolerant plants.

This soil is valueless for farming and is of very little value for grazing. It is inextensive and is restricted to low flats or depressions north and northwest of the Salt Lake Airport, along the southern end of Black Slough, and near the southwestern shore of Utah Copper Lake. The total extent is 2.4 square miles.

In a few areas the surface is covered with water most of the time, even during dry years. The soil in these areas is similar in every way to that in the less wet areas.

MISCELLANEOUS SOILS AND LAND TYPES, LARGELY NONARABLE

The group of miscellaneous soils and land types includes areas that for one reason or another are almost wholly unsuited to the production of crops. It includes very stony soils of the Bingham and Wasatch series, the loose Preston fine sand and Oolitic sand, rough broken land, rough broken and stony land, riverwash, pits and dumps, and unclassified city land.

Some of the areas are valuable for residential, commercial, or industrial uses, and others have limited value as range for livestock.

Bingham stony loam.—This soil is similar in character of soil material to Bingham gravelly loam, but it has a large quantity of stone on the surface and embedded in the fine soil material. The quantity of stone differs in different parts of the areas. It is concentrated in some areas, and in others it is less abundant. In most of the areas, however, it is sufficient to render the soil of little or no value for farming, but small, scattered patches could be used for dry-farmed grains. The native vegetation consists mainly of sagebrush, rabbitbrush, and a thin stand of bunchgrasses, which have some value for grazing, together with an occasional patch of scrub oak and mountain maple. The soil occurs in extensive bodies in the southwestern part of the area and in less extensive bodies south of Fort Douglas and north of Little Cottonwood Creek.

Wasatch stony loam.—This soil type includes areas of stony and excessively gravelly soils. The stones range in size from pebbles to boulders, and the finer soil material from gritty loam to coarse sandy loam. The largest areas are on alluvial fans northwest of the mouth of Little Cottonwood Canyon, and there are small bodies south of Big Cottonwood Creek, and south of Little Cottonwood Creek near the foot of the Wasatch Mountains.

Except for the excessive quantity of stone and gravel, this soil is similar to Wasatch loam and Wasatch coarse sandy loam. The substratum is a porous mass of gravel and stone.

This soil is too stony or gravelly and has too low moisture-holding capacity to be suitable for the production of crops. The principal

vegetation is downy chess (cheatgrass), which affords some early spring grazing. Some of the higher areas support oak brush, mountain maple, and sagebrush.

PRESTON SERIES

The Preston series includes loose, porous sandy soils that are commonly subject to wind drifting. They are pale brown or light yellowish brown but contain grains of dark-colored sand. They are noncalcareous or slightly calcareous and have little or no development of a profile and no layer of lime concentration. The topmost few inches of sandy material in some places is slightly darker than the underlying sand and contains a small quantity of organic matter. The loose sandy material is underlain, within 6 feet in some places, by old alluvial-fan or lake-laid materials.

Preston fine sand.—This soil consists of pale-brown or light yellowish-brown fine sand to a depth of 3 feet or more. It is loose and hummocky. On the west side of the valley most of the soil is calcareous and has been accumulated by wind over Bingham soils and to a minor extent over Taylorsville soils. On the east it lies over coarse sandy material of the Wasatch soils.

A sparse vegetation, consisting of rabbitbrush, sagebrush, downy chess (cheatgrass), and in some places mustard, grows where the surface is not shifted too frequently by the wind. In some localities there is a scattered stand of bunchgrasses. The soil is of some value for grazing but is almost entirely unsuited to the production of crops.

The total extent of Preston fine sand is 2.1 square miles.

Oolitic sand.—Oolitic sand consists of loose light-gray or light yellowish-gray sand made up of small spherical particles of lime carbonate resembling fish eggs. It occurs along the shores of the Great Salt Lake and lies both on the beach and in adjoining dunelike or hummocky wind-shifted strips. In some places the sand overlies a calcareous hardpan. Some areas within this soil are barren, but generally it has a rather sparse vegetative cover consisting of downy chess (cheatgrass), bunchgrass, rabbitbrush, and some greasewood here and there. The total area of Oolitic sand, which is nonarable, is 2.5 square miles.

Rough broken land (Bingham soil material).—This is an extensive land type, consisting of steep slopes or rough uneven land with gravelly soil material like that of the Bingham soils but containing a greater percentage of gravel than Bingham gravelly loam. Both surface soil and subsoil commonly contain many stones and boulders.

Owing to its unfavorable relief and gravelly and stony character, this land type is distinctly nonarable. The larger bodies are in the southwestern part of the area, and some are in the vicinity of Salt Lake City. Its total extent is 20.5 square miles. Near the foothills the vegetation consists largely of patches of oak brush and of mountain maple, with sagebrush and bunchgrasses in the open spaces; and farther out in the valley the vegetation consists largely of sagebrush and rabbitbrush.

This land type furnishes a limited amount of grazing, and areas

in the vicinity of Salt Lake City are used for residential purposes and as a source of sand and gravel for commercial use.

Rough broken land (Wasatch soil material).—This land type occupies areas of rough or steep land with stony soil, adjacent to the soils of the Wasatch series. The soil material is of coarse texture, is derived from granitic and quartzite rocks, and is similar to the materials of the Wasatch soils. The larger areas occur only along present or old drainage courses or outwash fans of Dry Cottonwood Creek, Little Cottonwood Creek, and minor drainage channels north of Draper and south of Union. They support a growth of downy chess (cheatgrass), sagebrush, and rabbitbrush, and they have value only as grazing land. The total area is 2,944 acres.

Rough broken land (Welby and Taylorsville soil materials).—This land type has a total area of 2 square miles but occupies only long, narrow strips on bluffs or steep terrace fronts. The surface soils are thin and where not well covered with vegetation are subject to rapid erosion. The soil materials are light gray and limy and are similar to those underlying the Welby and Taylorsville soils.

The land is too steep or too rough to be suitable for cultivation. It supports some brush and grass and has some value for grazing.

Rough broken and stony land.—This land occurs on the outer edges of the area, mostly on the lower slopes of the surrounding mountains. It includes areas that are so steep, rough, and stony that they are nonarable. The soil is shallow or, in some places, entirely lacking. It produces only a scant growth of shrubs and grasses and has low value for grazing.

The total extent of this land type is 30.9 square miles.

Riverwash.—Riverwash consists of loose gravelly and stony wash material in the stream channels. It supports little or no vegetation and is practically valueless for agricultural use. It is widely distributed and occurs in small patches or narrow strips. It is not extensive, there being only 0.9 square mile in the entire area.

Pits and dumps.—The milling and smelting of copper ore are important industries in the Salt Lake area. Considerable acreages are used as dumps for tailings from the mills and slag from the smelters. Gravel and sand are obtained from thick deposits underlying the Bingham, Parleys, and Wasatch soils. Many pits, with a considerable aggregate acreage, are supplying the extensive demand for these materials for highway and railroad construction and maintenance and for making cement. The total extent of the pits and dumps is 12.6 square miles.

Unclassified city land.—A rather large part of Salt Lake City is built up so thickly that the character of the soil is not only very hard to determine but also has little significance. The same is true of certain railroad and industrial properties in and south of the city. The soils in these areas are not classified and for the most part have no agricultural significance, although they are used for lawns and gardens in residential districts of the city. If classified, probably most of them would be in the Bingham, Logan, and Red Rock series.

PRODUCTIVITY RATING AND SOIL-USE GROUPING

In table 5 the soils of the Salt Lake area are listed and estimated average acre yields of the more important crops are given for each soil. Figures in parentheses indicate estimated expected yields on soils for which no actual yield records were obtained. Many of these soils are not yet adequately supplied with water for irrigation but will receive an additional supply under new projects.

This table gives a general idea of yields that may be expected on each soil type under the prevailing system of irrigation farming. It is based on information gained in interviews with farmers, from farm records, and from observations by the field party during the progress of the soil survey. Yield estimates for soils not now under cultivation or for those for which no adequate records were obtained were made after careful consideration of soil characteristics and comparison of these soils with others for which accurate information was obtained.

Common farming practices under irrigation include a rather indefinite rotation including the growing of alfalfa for a number of years, small grains for a year or two, and one or more cultivated crops. Commercial fertilizers are not commonly used on most crops, but barnyard manure is returned to the land. Superphosphate is commonly used on sugar beets. It is used on alfalfa by a few farmers.

The common dry-farming practice consists of growing wheat, with summer fallow in alternate years.

In table 6 the soils are arranged in the order of their comparative productivity and suitability for growing the common crops of the area under irrigation. They are characterized as to general productivity, ease of management, and water-holding capacity, and are placed in a few groups as to their physical suitability for irrigation farming and dry farming.

TABLE 5.—*Estimated average acre yields of the principal crops on each soil in the Salt*

Soil (soil type, phase, or land type)	With irrigation: Alfalfa hay	Sugar beets	Wheat	Oats	Barley	Potatoes	Peas (canning)	Vegetables [2]	Tree fruits and grapes [2]	Pasture	Without irrigation: Wheat
	Tons	*Tons*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Tons*			*Cow-acre-days* [3]	*Bushels*
Airport loam										(50)	
Airport loam, deep phase	(2½)	(10)	(20)	(35)	(35)					(100)	
Avon gravelly loam	(3)	(12)	(35)	(45)	(40)						(16)
Bingham loam	3	(14)	37	50	50	300		Fair	Fair to good.	(150)	17
Bingham loam, deep phase	4	15	40	55	55	(300)	2	Good	do	(175)	18
Bingham gravelly loam	2½	12	35	45	40	(200)	1½	Fair	Fair	(125)	16
Bingham gravelly loam, deep phase	(3½)	(14)	(40)	(55)	(50)	(220)	(2)	do	do	(160)	(17)
Bingham gravelly loam, steep phase									do		(12)
Bingham very gravelly loam									do	(75)	(14)
Bingham coarse sandy loam	(2)		(25)	(30)	(30)				do	(100)	(12)
Bingham fine sandy loam	3	12	35	50	50			Fair	Fair to poor.	(150)	(15)
Bingham gravelly fine sandy loam	(2½)		(25)	(30)	(30)			do	Fair	(100)	15
Bingham stony loam											
Churchill loam [4]	3½	10½	23	41	39	250	1¼	Fair	Fair	(175)	
Decker loam [5]										(100)	
Decker loam, well-drained phase	3½	(15)	40	55	55	(250)		Good	Fair to good.	(200)	
Decker sandy loam [5]								Fair to poor.		(125)	
Draper loam	4	18	45	60	60	250	2	Good	Good	(250)	
Draper loam, poorly drained phase [4]	(2½)	(15)	(30)	(50)	(35)			Fair to good.		(200)	
Draper loam, shallow phase (over Taylorsville soil material) [4]	(2)	(12)	(25)	(40)	(30)			do		(150)	
Draper coarse sandy loam	(3)	(13)	(32)	(45)	(45)	(200)	1¾	Fair	Good	(150)	
Gooch clay loam										(50)	
Gooch loam										(50)	
Knutsen loam	(3)	(13)	(30)	(40)	(40)	(200)	1¾	Fair to good.	Good	(200)	

Knutsen loam, poorly drained phase.										(175)	
Knutsen gravelly loam										(100)	
Logan clay (better drained areas) [4]	3	15½		55	50			Fair to good.		(170)	
Logan clay (more poorly drained areas).										(120)	
Logan loam [4]	(3½)	(18)	45	(60)	(60)	(250)	1½	Fair to good.		(250)	
Logan loam, alluvial-fan phase	(3½)	(18)				(250)	(2)	Good to excel-lent.			
Logan silty clay loam (better drained areas).[4]	(3)	(15)		(50)	(50)			Fair to good.		(170)	
Logan silty clay loam (more poorly drained areas).										(120)	
Logan silty clay loam, alluvial-fan phase.	(3)	(18)					(2)	Good to excel-lent.			
Oolitic sand											
Parleys loam	(4)	(16)	(40)	(60)	(60)	(250)	(2)	Good	Good	(200)	
Parleys loam, gravelly phase	(3)	(12)	(30)	(40)	(40)	(200)	(1½)	Fair to good.	do	(140)	
Parleys silty clay loam	(4)	(16)	(40)	(60)	(60)	(225)	(2)	Good	do	(200)	
Pits and dumps											
Preston fine sand											
Red Rock loam	4¼	14½	45	65	60	300	(2)	Good		(250)	18½
Red Rock gravelly loam	(3)	(10)	30	50	45	(150)	(1½)	do	Fair to good.	(170)	(15)
Red Rock clay loam	4	15	45	65	60	200	2	do	do	(250)	(18)
Red Rock silty clay loam	4	16	47	65	60	300		Fair	Fair	(250)	
Red Rock silty clay loam, poorly drained phase.	(3)	(12)	(32)	(50)	(45)	(200)				(185)	
Red Rock fine sandy loam	4	16	37	55	55	(250)	(2)	Good	Good	(225)	
Red Rock fine sandy loam, poorly drained phase.[5]										(185)	
Riverwash											
Rough broken land (Bingham soil material).											
Rough broken land (Taylorsville and Welby soil materials).											
Rough broken land (Wasatch soil material).											
Rough broken and stony land											
Saltair clay [4]											
Saltair clay, mucky phase [6]											
St. Marys loam	(3½)	(15)	(35)	(50)	(45)	(300)		Good	Good	(200)	

See footnotes at end of table.

TABLE 5.—*Estimated average acre yields of the principal crops on each soil in the Salt Lake a*

Soil (soil type, phase, or land type)	With irrigation										Without tion
	Alfalfa hay	Sugar beets	Wheat	Oats	Barley	Potatoes	Peas (canning)	Vegetables [2]	Tree fruits and grapes [2]	Pasture	Wheat
	Tons	*Tons*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Tons*			*Cow-acre-days* [3]	*Bushels*
Taylorsville loam	4	16	44	57	58	250	2	Good	Good	(250)	
Taylorsville silty clay loam	4¼	18	45	61	59	270	1¾	Fair	Fair	(225)	
Taylorsville silty clay loam, hardpan phase.	(3½)	(15)	(35)	(50)	(45)	(250)	(1½)	do		(185)	
Taylorsville silty clay loam, poorly drained phase.[5]										(170)	
Taylorsville silty clay loam, overwash phase.	(2½)	(15)	(30)	(50)	(35)			Fair		(150)	
Taylorsville silty clay loam, shallow phase (over Bingham soil material).	3½	(15)	37	43	42			do	Fair	(160)	
Taylorsville loamy fine sand	3½	16	40	55	54	200		Good	Good	(185)	
Terminal loam										(40)	
Terminal silty clay loam										(40)	
Unclassified city land											
Wasatch coarse sandy loam [7]								Fair to poor.	Fair	(70)	
Wasatch coarse sandy loam, poorly drained phase.[5]										(100)	
Wasatch gravelly coarse sandy loam.[7]										(70)	
Wasatch loam [7]	(2½)		(25)	(30)	(30)	(150)	(1)	Fair	Fair	(125)	
Wasatch loamy sand [7]									Fair to good.	(50)	
Wasatch sand [7]									Fair		
Wasatch sandy loam, shallow phase (over Welby soil material).	(3)	(12)	(30)	(40)	(35)	(175)		Fair	do	(120)	17
Wasatch sandy loam, shallow poorly drained phase (over Welby soil material).										(120)	
Wasatch stony loam											
Welby loam	4	16½	43	55	58	400		Good	Good	(250)	15

Welby loam, poorly drained phase[4]	(3½)	(14)	(37)	(50)	(50)	(250)	----	Fair	----	(200)	----
Welby loam, hardpan phase	(3½)	(14)	(35)	(45)	(45)	(250)	----	Good	Fair	(200)	----
Welby loam, sloping phase	(3)	----	----	----	----	----	----	----	do	(60)	----
Welby fine sandy loam	4½	17	42	60	60	250	----	Good	Good	(250)	----
Welby fine sandy loam, poorly drained phase.[4]	3½	(14)	(37)	(50)	(50)	----	----	----	----	(200)	----
Welby fine sandy loam, sloping phase.	(3)	----	----	----	----	----	----	----	Fair	(50)	----
Welby silty clay loam	4	15½	(45)	(55)	(55)	(300)	----	Fair	do	(250)	----

[1] These are estimated average yields based upon information gained from farmers and from observation during the progress of th probable approximate yields that may be expected under adequate irrigation on soils for which yield data are not available. A blank adapted or is not commonly grown.

[2] Lack of sufficient information and the considerable variety of vegetables and fruits grown make it infeasible to give single figures fo general qualitative terms are used.

[3] The term "cow-acre-days" is used to express the carrying capacity of pastures. It is the product of the number of animal units car the animals can be grazed without injury to the pasture. For example, a soil type able to support 1 animal unit to the acre for the pasture, whereas another soil type able to support 1 animal unit on 2 acres for 180 days would produce 90 cow-acre-days, and a soil ty 10 days would produce 40 cow-acre-days.

[4] These estimates refer to production on the better areas of these soils. Lower yields are obtained on areas in which the soils are sh content is higher.

[5] These soils are mostly poorly drained and salty. Some areas are better drained and less salty and are used for the production of cr degree of poor drainage and salt concentration.

[6] These soils produce considerable growth of tules, sedges, and similar coarse vegetation but are so wet that livestock can seldom g

[7] Frequent light irrigation is essential to avoid loss of irrigation water and soil fertility.

TABLE 6.—*General grouping of the soils of the Salt Lake area, Utah, as to their suitabili*

Soil	Productivity [2]	Relative ease of management [3]	Water-holdi capacity
Logan loam, alluvial-fan phase	High where adequately irrigated and well managed; medium to low under dry farming.	Easy	High
Logan silty clay loam, alluvial-fan phase		Fairly easy	do
Draper loam		Easy	Medium to h
Red Rock loam		do	High
Red Rock clay loam		Fairly easy	do
Red Rock silty clay loam		do	do
Decker loam, well-drained phase		Easy	do
Welby loam		do	do
Welby silty clay loam		Fairly easy	do
Red Rock fine sandy loam [5]		Easy	Medium to h
Parleys loam		do	do
Parleys silty clay loam		Fairly easy	do
Welby fine sandy loam [5]		Easy	do
Welby loam, hardpan phase		do	High
Taylorsville loam		do	do
Taylorsville silty clay loam		Fairly easy	do
Taylorsville silty clay loam, shallow phase (over Bingham soil material).		do	Medium to h
Taylorsville silty clay loam, hardpan phase		do	do
Taylorsville loamy fine sand [5]		do	do
St. Marys loam		Easy	do
Red Rock silty clay loam, poorly drained phase	High to low under irrigation, depending on drainage conditions and salt concentration.	Drainage and removal of excess salts range from easy to difficult on these soils; otherwise, they are mostly easily or fairly easily handled.	High
Draper loam, poorly drained phase			do
Draper loam, shallow phase (over Taylorsville soil material)			do
Welby loam, poorly drained phase			do
Welby fine sandy loam, poorly drained phase			Medium to h
Red Rock fine sandy loam, poorly drained phase			do
Wasatch sandy loam, shallow poorly drained phase (over Welby soil material).			Medium
Logan loam			High
Logan silty clay loam [6]			do
Logan clay [6]			do
Knutsen loam, poorly drained phase			Medium
Decker loam			do
Decker sandy loam			do
Taylorsville silty clay loam, overwash phase			High
Taylorsville silty clay loam, poorly drained phase [6]			do
Bingham loam, deep phase	Fairly high where adequately irrigated; moderate to low under dry farming.	Fairly easy	Medium to h
Knutsen loam		do	
Bingham loam		do	
Bingham fine sandy loam		do	
Draper coarse sandy loam		do	
Red Rock gravelly loam		Somewhat difficult	
Parleys loam, gravelly phase		do	
Bingham gravelly loam, deep phase		do	

Bingham gravelly loam	Medium to high if adequately irrigated, but require rather frequent irrigation; medium to low under dry farming.	Somewhat difficult	Rather low
Bingham coarse sandy loam		do	do
Bingham gravelly fine sandy loam		do	do
Bingham very gravelly loam		Difficult	do
Avon gravelly loam		Somewhat difficult	do
Wasatch sandy loam, shallow phase (over Welby soil material)		do	do
Welby loam, sloping phase [7]		Rather difficult	Medium
Welby fine sandy loam, sloping phase [7]		do	do
Wasatch loam		Fairly easy	Rather low
Churchill loam		do	do
Wasatch coarse sandy loam	Medium to low under irrigation; low under dry farming.	do	do
Wasatch coarse sandy loam, poorly drained phase		do	do
Knutsen gravelly loam		Difficult	do
Bingham gravelly loam, steep phase [7]		do	do
Wasatch gravelly coarse sandy loam		do	Low
Wasatch loamy sand [5]		Rather difficult	do
Wasatch sand [5]		do	do
Gooch loam	Low for crops; medium to low for pasture.	Difficult to provide adequate drainage and remove excess of salts.	High
Gooch clay loam			do
Airport loam, deep phase			do
Airport loam			do
Terminal loam			do
Terminal silty clay loam			do
Bingham stony loam		Very difficult	Rather low
Wasatch stony loam		do	do
Preston fine sand [8]		do	Very low
Oolitic sand [8]		do	do
Saltair clay, mucky phase	Negligible	Practically impossible	High
Saltair clay			do
Rough broken land (Welby and Taylorsville soil materials) [7]			Medium
Rough broken land (Bingham soil material) [7]			Low
Rough broken land (Wasatch soil material) [7]			do
Rough broken and stony land [7]			do
Riverwash [7]			do
Unclassified city land			
Pits and dumps			

[1] This refers to the suitability of the soil as to physical properties and disregards the less stable economic and social factors.
[2] Productivity as used here means the capacity to produce the common crops of the area under prevailing farming practices.
[3] This refers to the ease of tillage, of handling farm machinery, and of distributing irrigation water.
[4] Water-holding capacity of a soil determines to considerable extent the efficiency of water use.
[5] These soils in some places are subject to injurious soil blowing or wind erosion.
[6] Some areas of these soils that contain a rather high concentration of salts probably would be difficult to reclaim.
[7] These soils are subject to severe erosion by water if not covered by thick-growing vegetation.
[8] These soils are subject to severe wind erosion and drifting.

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In this classification, geographic and economic factors, such as location and pattern of distribution of soil types, transportation and marketing facilities, and prices of agricultural products, are ignored. Consideration is given to the ability of the soils to produce crops under the common farming practices of the region; to the ease or feasibility of handling farm machinery and distributing irrigation water; to the water-holding capacity of the soils, which to a considerable extent determines the quantities of water needed and when they shall be applied; and to the danger of destructive erosion when the land is cleared for cultivation or heavily grazed.

Because of limitations in the amount of detail that may be shown on a soil map and the unavoidable inclusion of considerable variations within areas of soil types as mapped, these ratings should not be considered to apply strictly to all areas of a soil type. Variations in drainage conditions and in concentration of salts cause corresponding variations in productivity and suitability for crop production, especially in soils mapped as poorly drained phases. Areas that are poorly drained or salty are less productive than the better drained areas. The salt concentrations are shown on the alkali map by red boundaries and symbols. Areas with moderate salt concentrations are generally poorer than those that are comparatively salt free, whereas those having strong salt concentrations are generally unfit for cultivation unless reclaimed by special measures.

LAND USES AND FARMING METHODS

USE SUITABILITY OF SOILS

The natural grouping of soils shown on the soil map at the end of this report and discussed in the section on Soils and Crops may be interpreted in a general way to show the suitability of the individual soils to various agricultural uses. Such an interpretation can only be very general, however, as there is a rather wide range of soil characteristics in each natural group.

The well-drained soils of the terraces and alluvial fans are mostly of medium- and fine-textured materials, have good moisture-holding capacity, and are well-suited to the growing of a wide variety of crops under irrigation. The well-drained and excessively drained soils of the higher alluvial fans are largely of gravelly and sandy materials, have lower moisture-holding capacity, and are generally less productive than those of the first group; although some of them—particularly the Bingham soils—are fairly well-suited to the production of dry-farmed wheat, and others are well-suited to the production of fruits under irrigation. The imperfectly and poorly drained soils of the bottom lands and of the lower and flatter areas on the terraces and alluvial fans have a great range in present use and suitability for use, depending on the actual drainage condition and the concentration of salts. The poorly drained soils of the lake plain are mostly strongly affected with soluble salts (alkali) and are largely nonarable. The miscellaneous soils and land types are almost wholly nonarable, but most of them have some slight value as range for livestock.

A more specific classification of the soils as to their use suitability is shown in table 6, page 64. A comparison of this grouping or classification with the grouping on the map will show that the

two are not identical and that some of the groups in the use-suitability grouping contain members of several of the natural groups, and vice versa.

The ideal soil for the production of a wide variety of crops under irrigation, as well as for dry farming, is a smooth and very gently sloping, deep, medium-textured, mellow, permeable, fertile soil that is well drained and comparatively free from soluble salts but has high water-holding capacity. The soils in the first group are the nearest approach to this ideal, though probably none of them is entirely ideal; the soils and land types of the sixth group are farthest from the ideal; and the soils of the other classes are intermediate in their degree of suitability for the production of crops. Some soil types and phases, especially those that are subject to imperfect or poor drainage and concentration of salts, vary greatly in their productivity and present suitability for use; and many of them may be improved by special practices, such as artificial drainage and leaching.

The soils of the first group include most members of the Welby, Taylorsville, Parleys, Red Rock, Draper, and St. Marys series and some of the better drained soils of the Logan and Decker series. They are soils of good depth, medium to high water-holding capacity, easily or fairly easily worked, and of high productivity where properly managed.

The alluvial-fan phases of the Logan soils are the only imperfectly drained soils in this group, and these are practically free from soluble salts and are highly productive for truck crops, among which celery, sweet corn, and asparagus are especially important. Deep-rooted crops like alfalfa and tree fruits are generally not well adapted to the Logan soils.

The Taylorsville soils have fine-textured subsoils and absorb water slowly, but with reasonable care in the use of irrigation water they are among the most productive soils of the area for general farming under irrigation.

The Welby, Red Rock, Parleys, and Draper soils and the well-drained phase of Decker loam have generally medium-textured permeable subsoils. They are among the most productive soils in the area and are easily tilled and irrigated. The St. Marys soils have desirable characteristics, and if favorably situated for irrigation they would doubtless be well suited to the production of crops.

The imperfectly and poorly drained soils of the bottom lands and the lower lying areas on terraces and alluvial fans vary so greatly in their present use and in their probable suitability for future use that they cannot be placed in a definite class, although many of them are grouped as potentially First- and Second-class farming land. Others are classed as Fourth- and Fifth-class land and are suitable for pasture but poorly suited to the production of cultivated crops.

Limited areas of the Logan soils and some poorly drained phases of other soils are used for the production of truck crops, particularly celery, and considerable areas could probably be used for this purpose. In the main, however, these soils are used for and well adapted to farm pastures. Most of the pastures are unimproved, but with some cultivation and reseeding of forage plants adapted to wet lands they could be much more efficiently used. The Utah Agricultural Experiment Station has under way a study on farm pasturage. A recom-

mendation resulting from this study, which will apply to a large part of the soils in this group, is to thickening native pastures by applying a mixture of seeds of plants adapted to wet soils that contain some alkali. The mixtures have been tried on similar wet lands of the State and have greatly increased the carrying capacity of such land. The recommendation would apply particularly to members of the Logan and Gooch series and to some of the poorly drained phases of other soils in the group, which are not too wet and contain only moderate concentrations of alkali.

The soils of the Bingham and Avon series are used mostly for growing wheat under dry farming, and except in years of low spring rainfall they are fairly productive. These soils are placed mostly with the Second-class and Third-class farming land and are considered well suited or fairly well suited to the production of crops under irrigation. Irrigated crops on these soils and on the Churchill soils are often somewhat patchy or spotted, owing to unfavorable moisture conditions, especially in places where the soil is very shallow over porous gravel or hardpan. Some spots within individual fields may drain too slowly, whereas much of the area is excessively drained. The deep phases of these soils are generally highly productive.

Most of the Wasatch soils, Knutsen gravelly loam, and some of the steeper areas of the gravelly Bingham soils are placed in the Fourth-class soils and are considered fair to poor soils for farming under irrigation, fairly well adapted to fruit growing, but poorly suited or unsuited to dry farming. All these soils have a low moisture-holding capacity and require frequent irrigation and care to prevent excessive waste of water through downward percolation.

The poorly drained and salty soils making up the Gooch, Airport, and Terminal series are placed in the Fifth class and are considered poorly suited or unsuited to either irrigation or dry farming. They furnish fair to poor pasture or range for livestock.

Numerous attempts have been made to drain soils of the Terminal and Airport series. In 1907 the Bureau of Soils reported the results of an investigation conducted cooperatively between the Bureau and the Utah Agricultural Experiment Station on Reclamation of Alkali Land in Salt Lake Valley, Utah (*4*). The area reported reclaimed (the "Swan Tract") is 4 miles west of Salt Lake City in sec. 5, T. 1 S., R. 1 W., on soils classified in the present survey as Airport. Today the Swan Tract is not different from the surrounding areas, which contain high concentrations of soluble salts and are poorly drained. The reason, or at least a partial reason, for the failure of a permanent reclamation may be in the shallowness of the drains and the consequent failure to rid the lower part of the subsoil of soluble salts. Reclamation has been attempted in other localities on the Airport, Terminal, and Decker soils. Limited areas of the Decker soils have been successfully reclaimed, but so far as known, reclamation has been unsuccessful with the Airport and Terminal soils and with other soils of the lake plain.

Sixth-class land is made up of a miscellaneous group of soils and land types having one or more characteristics that make them almost entirely unsuitable for the production of crops. Some of them are excessively stony, others are extremely loose and sandy, others are very rough and steep, others are very wet and salty, and still others

are frequently overflowed. Most of these soils and land types have some value as range for livestock, especially in fall, winter, and spring. Some areas have value as residential and industrial sites, for recreational purposes, and for wildlife propagation.

FERTILIZATION

The principal fertilizers used on soils of the Salt Lake area are barnyard manure and a soluble phosphate, usually treble superphosphate. Barnyard manure is regarded as especially valuable for most crops, and phosphate appears to give a significant increase in yield of sugar beets. Yields of alfalfa on some of the soils may be increased by the use of phosphate, although the practice is not common as yet.

CROP ROTATION

In general farming practices, alfalfa is the most important crop grown, and in any system of rotation it naturally has an important place.

Two general types of rotations are widely practiced. One, used chiefly by dairy farmers, consists of alfalfa, 3 or 4 years; corn for silage, or potatoes, 1 year; sugar beets, 2 years; and small grain as a nurse crop for alfalfa, 1 year. The other rotation includes alfalfa, 3 or 4 years; small grain, 1 year; sugar beets, 2 years; and small grain with alfalfa, 1 year.

In the dry-farming area the cropping practice consists of growing small grain, generally a variety of winter wheat, which is seeded in the fall. The year following the harvest of the wheat crop the land is summer-fallowed, this practice consisting of plowing in the fall or the following spring and giving sufficient additional cultivations during the summer to keep the land free from weeds.

Dry farming is usually done on a fairly large scale, with the use of power equipment for all phases of the work, including harvesting, which is accomplished largely with combined harvesters.

CROP VARIETIES

Very little agricultural experimental work has been conducted in this area, although the Utah Agricultural Experiment Station and the Division of Cereal Crops and Diseases of the Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, have conducted variety tests of small grains and corn for several years. Most of these tests were conducted on Welby fine sandy loam and Welby loam, which are widely distributed and are very important for general farming under irrigation. Varieties grown in the test plots include the more important ones that are being grown by local farmers and new varieties that are thought to be promising.

Spring wheat varieties that appear to be most promising include Dicklow and Federation, which are commonly grown, and Erect, a new improved variety, the growing of which is increasing rapidly throughout the country. All these are susceptible to rust, which commonly does considerable damage. It is likely that new rust-resistant varieties will soon be developed.

The barley varieties that have given the best results include Trebi, a standard in the area, which usually lodges badly, and Velvon, a

new variety, which is proving superior to Trebi in ease of handling and lack of lodging and equal in yielding ability. The acreage planted to Velvon is being increased rapidly, and this variety seems likely to be the most important grown in the near future.

In the oats tests, Uton, a cross of Markton and Swedish Select, is a new improved variety that has consistently outyielded Swedish Select, which is most generally grown at present. Uton has been resistant to the smuts occurring in this area.

Corn tests give definite indication of the superiority of a number of new hybrid varieties for the production of silage. One of the most promising is now known as U. S. Hybrid 52, which in preliminary tests has far outyielded Improved Leaming.

In addition to the small-grain and corn tests, the Utah station conducted tests of 36 varieties and strains of alfalfa, primarily to obtain desirable varieties resistant to bacterial wilt. A few varieties now appear to be very promising and in the near future will be grown on a commercial scale for the production of seed, which will be made available to local farmers.

These tests were conducted northeast of Midvale on the well-drained phase of Decker loam and on Welby silty clay loam, which are extensive soils and are considered good land for general farming.

PLANT DISEASES, INSECT PESTS, AND WEEDS

The control of plant diseases and insect pests is a major problem in the agriculture of the area. Bacterial wilt of alfalfa is serious in most of the agricultural lands and necessitates frequent reseeding of alfalfa. Another important disease of alfalfa in this area is bacterial stem blight, which is now being investigated by State and Federal pathologists. The alfalfa nematode also does considerable damage to the alfalfa crop.

Curly top disease of sugar beets, which for a time threatened the existence of the sugar-beet industry, has recently been controlled, largely by the planting of resistant varieties. The sugar-beet nematode is widespread in the areas where sugar beets have been grown. In areas where the nematode exists, sugar beets can be grown only at infrequent intervals.

The small grains, when grown on irrigated land, are often infested with rust, which did considerable damage to spring wheat in 1937 and 1938. As previously indicated, the control of this disease depends on the breeding of varieties resistant to the forms of rust that are prevalent in this area.

Diseases and insect pests do considerable damage to truck crops and fruits, but control measures are known for many of them, and others are being investigated.

The noxious-weed problem is serious in the area, and large tracts of otherwise good land are infested. The weeds that do most damage are whitetop and morning-glory. During the last several years considerable time has been given to the control of noxious weeds by the office of the county agricultural agent, which, with the aid of Federal funds, started extensive experiments in 1934. Results of these studies give promise of being highly successful and of returning to productive use large acreages infested with whitetop and morning-glory.

IRRIGATION, DRAINAGE, AND ALKALI

Irrigation is essential for the intensive production of a rather wide variety of crops in the Salt Lake area. Although small grains, principally wheat, are grown under dry farming, the acre returns are low. The land is much more productive where properly and adequately irrigated. Drainage also is an important consideration on many of the soils of the area, particularly in the irrigated districts. Poor drainage and consequent concentration of soluble salts lower the productivity of many soils and in some places render them unfit for crop production.

About 26,000 acres of arable land in the southwestern part of the area is used for growing cereals without irrigation. As has been stated, this type of farming is generally called dry farming and consists of a year of fallow followed by a year of a cereal crop, usually wheat. Even though the acre yields are generally low under dry farming, it constitutes a desirable supplement to irrigation farming in the area. Much of the equipment essential for operating the dry farm can be used on the irrigated farm, and the planting and harvesting of the cereal crop and the attention to the fallow land on the dry farm come at times when less attention is needed in the operation of the irrigated farm.

Irrigation has been practiced in the area since July 24, 1847, the day the first party of Mormon pioneers entered the valley. According to Widtsoe (*17*), the pioneers—

> on that day planted potatoes in what is now the business section of Salt Lake City, and gave the soil a "good soaking" of water brought from the neighboring City Creek through a plow furrow that served as a ditch.

A further quotation (*17*) indicates the zeal with which the pioneers developed the art of irrigation:

> The Mormon pioneers possess the honor of having founded modern irrigation in America, not because of the initial irrigation on July 24, 1847, but because the Mormon people continued the work, dug extensive canals, brought thousands of acres under irrigation, devised methods of irrigation, established laws, rules and usages for the government of populous settlements living "under the ditch,"—in short, because they developed permanent irrigation agriculture on a community scale, under the conditions and with the knowledge of modern civilization.

At the present time the net irrigated acreage in the area is probably more than 60,000 acres. A recent survey of a part of the valley by Israelsen and Clyde (*8*) reports a net irrigated acreage of 47,711 acres. Two important irrigation systems on the west side of the valley were not included in this survey. It did not, for instance, include the land under the Utah Lake Distributing Co. or that under the Provo Reservoir Co. canals and some other smaller units. It should be noted that the figure given is for net irrigated area. This area was measured directly, and all land not showing evidence of irrigation, such as land used for canals and laterals and land not producing crops, was excluded.

The sources of the supply of irrigation water are the Jordan River and the Provo River, with Utah Lake, located in Utah County, as a storage reservoir, and a number of smaller streams that issue from the Wasatch Range and the Oquirrh Mountains. The more important of these smaller streams are Mill, Parleys, Big Cottonwood, and Little Cottonwood Creeks. At present Utah Lake offers the only storage

capacity for the area, but the Deer Creek irrigation project is under construction. Included in this project is a reservoir in Provo Canyon that will store 150,000 acre feet of water and will provide water by gravity flow to the two higher canals on the west side of the Jordan River, thereby doing away with expensive pumping; and it will also supply the lands under these canals, together with other canals of the area, with irrigation water for the latter part of the growing season.

Two general methods of irrigation are commonly used in the valley. They include the flooding and the furrow methods. Of the 23,040 acres studied by Israelsen and Clyde (*8*) on the west side of the Jordan River, 14,325 acres, or 62 percent, were being irrigated by the furrow method, and 8,715, or 38 percent, by the flooding method. The study of approximately 20,000 acres of irrigated land on the east side of the Jordan River shows approximately the same distribution between the two methods.

The distribution of the water to individual farms is under the supervision of a water master. The water is usually distributed under a rotation system in which the interval between irrigations varies with different ditches from 7 to 21 days. The shorter rotations are necessary on the higher lying soils of coarse texture, especially those underlain by porous beds of sand or gravel, such as most of the soils of the Wasatch, Bingham, and Knutsen series. Considering the valley as a whole, the average length of the rotation is probably about 14 days.

Careful use of irrigation water is the concern of everyone depending on irrigation. For example, a farmer who overirrigates may waterlog not only his own field but parts or all of his neighbor's field. Conducting water through canals or ditches made in soils of coarse texture, especially those underlain by open, porous beds of sand and gravel, results not only in loss of water put into the ditch at great expense but in a higher water table in contiguous and nearby areas and in the accumulation of soluble salts in many such areas. Generally speaking, irrigation water is used with care; but important exceptions are evident to anyone acquainted with the conditions. Applications of excessively large quantities of water to lands under some of the canals in Salt Lake County are indicated in the report of Israelsen and Clyde (*8*).

A knowledge of the characteristics of the soil types is essential to wise and beneficial use of irrigation water. A large single application of water to soils like those of the Wasatch series results in the waste of a large part of the water applied and in the leaching of important plant nutrients from these soils. A large percentage of surface runoff results from heavy single applications of water to the Taylorsville soils, especially if the water is applied when the limy subsoil layer is dry. The condition of a large proportion of the 18 square miles of these soils naturally well drained but affected by seepage is a result of unwise and careless use of irrigation water and should arouse public opinion against such methods.

The total extent of imperfectly and poorly drained land within the Salt Lake area is large. Nearly all members of the Logan, Gooch, Terminal, Airport, Saltair, and Decker series are naturally imperfectly or poorly drained. The extent of all types of these series, which, with minor exceptions, are imperfectly or poorly drained, is approximately 134 square miles. In addition, poorly drained areas of soils that are normally well drained but have been

affected by seepage from irrigation total about 19.8 square miles. The total extent of imperfectly and poorly drained land, therefore, is about 153.8 square miles, or slightly more than one-third of the entire Salt Lake area. If the miscellaneous nonarable soils and land types, including rough broken land, rough stony land, riverwash, pits and dumps, unclassified city land, and excessively stony and sandy soils, are deducted from the total area of the survey, the imperfectly and poorly drained area comprises 56.8 percent of the land in the valley, leaving 43.2 percent of the area favorable for either dry farming or irrigation farming.

South of West Jordan and east of the Redwood road a number of fields in which the soils are largely of the Taylorsville and Welby series have been successfully tile-drained and are highly productive. Areas of the Draper soils near the town of Draper also have been tile-drained, but here, owing primarily to inadequate outlet facilities, drainage is still impeded. Mention has been made earlier of drainage experiments on the Airport soils west of Salt Lake City. Attempts to reclaim areas of Airport and Terminal soils by artificial drainage and irrigation have invariably failed.

Approximately 70 percent of the poorly drained phases of the Welby, Taylorsville, Red Rock, Wasatch, Knutsen, and Draper soils is in reality only imperfectly drained and is still under cultivation and producing fair yields of crops. In the remainder the soil is either too wet, too salty, or both, for any other use than pasture. Many areas could be improved by drains.

In the alluvial-fan phases of the Logan soils the water table is generally within 6 feet of the surface, but the soils contain comparatively little soluble salts and are highly productive for vegetable crops such as celery, asparagus, cabbage, sweet corn, and onions. This land is used largely as residential sites and to a minor extent for truck-gardening crops.

The concentration of soluble salts (alkali) in the soils of this area was carefully studied; a large number of soil samples were tested for their content of salts, and observations were made concerning the relation of salt concentration to soil type, drainage, and vegetation. The determinations of salt concentration were made with the Wheatstone electrolytic bridge. The salt concentrations in the surface foot of soil and in the 6-foot section were computed and used as a basis for setting up the grades of salt concentration shown on the alkali map. The various grades were established in order to show in a general way the effect of the salts on crop plants.

Areas in which the salt content, either in the topmost 12 inches of soil or as an average to a depth of 6 feet, is generally less than 0.2 percent are considered practically free of salts or only slightly saline and are shown on the map by the letter F. In such areas the soluble salts are not sufficiently concentrated to produce noticeably bad effects on plants.

Where the salt concentration ranges from 0.2 to 0.35 percent it is considered slight to moderate, and areas so affected are shown on the map by the letter W. In such areas some crops may be adversely affected, especially at the time when the seed is germinating and seedings are becoming established.

Concentrations between 0.35 and 0.65 percent are shown on the map by the letter M. The soils in such areas are considered mod-

erately to strongly affected. Crops growing on soils containing such concentrations are commonly spotted or uneven in growth.

Where the salt concentration is largely in excess of 0.65 percent the soil is considered strongly or excessively affected, and areas so affected are designated by the letter A. Such areas are generally unsuited to the production of crops.

It should be understood that the areas having the different grades of salt concentration are not uniform and that the salt concentration varies from season to season, even in any one location.

More than one-third of the total acreage of the Salt Lake area is affected with harmful concentrations of soluble salts. The total of all areas included in grade A (excessive concentration of alkali) is nearly one-fourth of the total area of the survey. The slightly and moderately affected areas are about equal and make up approximately 40,000 acres.

Considering only the alkali-affected areas, the A grade (excessively affected areas) make up more than 60 percent of the total. A large percentage of the strong soluble-salt concentrations occur in soils of the lake plain (pl. 4, *A*), in a solid block in the northwestern part of the area.

On the east side of the Jordan River, where there are no extensive areas of saline soils, the situation is distinctly different. Here the salt-affected areas include about 20 percent of the total, and the A grade (excessively affected) areas make up only about 2.3 percent of the total.

According to Dorsey (*4*)—

> The source of the alkali is probably the waters of Great Salt Lake (which within the memory of the older inhabitants has covered much of the low-lying lands) or in the case of the more elevated lands the waters of Lake Bonneville. The alkali is largely composed of sodium chloride with a smaller quantity of sodium sulphate and a small percentage of the chlorides, sulphates, and carbonates of calcium and magnesium. Sodium carbonate, black alkali, is often found, generally in small quantities.

Data obtained during the progress of the present study largely substantiate Dorsey's statements, although it seems probable that artesian water pressure and capillary rise of saline water are additional factors that operate to concentrate soluble salts in the surface soil. It appears likely that the failure of permanent reclamation of the Swan tract (*4*) was due to some extent to artesian pressure.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of environment acting on the parent soil material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the material. External climate, although important in its effects on soil development, is less so than internal soil climate, which depends not only on temperature, rainfall, and humidity, but on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly

influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The Salt Lake area is on the eastern rim of the Great Basin, that vast intermountain region that Marbut designated as the province of Northern Gray Desert soils (*10*). It lies at the foot of the lofty Wasatch Range and as a result has somewhat more rainfall than the adjoining desert area. Consequently, the soils have supported more grass than the soils of the desert area and are darker in color and contain more organic matter than Desert soils. Most of them have a medium to light brownish-gray or pale-brown color when dry, becoming dark brownish gray or dusky brown when wet. It appears that most of the mature zonal soils, which occupy gently sloping alluvial fans and terraces, belong to the great group of Brown soils (*1*, *9*), although some of them at the higher altitudes are somewhat darker and probably belong in the group of Chestnut soils (*1*, *9*). Large areas of soils on the lake plain in the northwestern part of the area are intrazonal—Solonchak and Solonetz—because of poor drainage and high content of salts; wet areas along the Jordan River and its tributaries are dark-colored and comparatively high in organic matter and represent the intrazonal Wiesenboden; and considerable areas of alluvial soils on alluvial fans, low terraces, and bottom lands are azonal, because they consist of comparatively young deposits that have been modified but little since deposition.

Many kinds of rocks and minerals have been transported from the mountains into the valley by the Jordan River and tributary streams, and these deposits are the parent materials from which most of the soils of the area have developed.

The main exposure (*3*) on the east side of that part of the Oquirrh Mountains lying west of the valley of the Jordan River consists of a great thickness of buff or tan quartzite, which in some localities is almost a sandstone, alternating with dark-blue, gray, or black limestone and dolomite. The southern half of the same part of this range has in addition a variety of Tertiary igneous rocks. In Bingham Canyon is an intrusive mass of quartzmonzonite in which large copper mines are located, and from this canyon south to the junction of the Oquirrh and Traverse Mountains, on the east side of the former range, there is an irregular distribution of volcanics, consisting of lava flows, tuffs, and agglomerates, mainly of intermediate or andesitic and latitic composition, although limited areas of rhyolite are present.

The Traverse Mountains, which border the valley to the south and connect the Wasatch Range and Oquirrh Mountains, have essentially the same rock composition as the Oquirrh, the volcanic rocks being confined largely to the western part. They differ from the Oquirrh, however, in the enormous deposit of Lake Bonneville sand near Jordan Narrows, which is a deep, narrow channel cut by the Jordan River, dividing the Traverse Mountains into two parts.

The volcanic rocks have had a considerable influence on the character of the soils developed on the alluvial slopes below them. Red Rock loam is clearly derived in large measure from the volcanic tuffs and breccias. Distribution of this soil closely adjoins the area covered by these rocks. Probably 75 percent or more of the total area of this soil is in the southwest part of the Salt Lake area.

The Wasatch Range (*13*) is more complex in structure and rock composition than the other two ranges of mountains. Extending from

the junction with the Traverse Mountains north to Little Cottonwood Canyon, the west front of the Wasatch Range consists of a granitic intrusion, with a very small amount of resistant quartzite and schist. The soils of the Wasatch and Draper series in this vicinity show very markedly their derivation from the granite. They consist of coarse sandy and gravelly material with abundant biotite mica and feldspar. These soils are most prominent in the Little Cottonwood Creek delta of Lake Bonneville and in the vicinity of Draper to the south. In some places this material has been transported a considerable distance out into the valley but is always readily identified by its characteristic appearance.

The northern part of the Wasatch Range consists mainly of limestones, shales, and sandstones. They have been complexly folded and faulted so that each formation generally outcrops as a narrow band (pl. 1, *B*). There is considerable mixing of materials during stream transportation of materials, and the soils show no marked relation to individual parent materials, although there is some correlation of lime content with distribution of formations. The range from Big Cottonwood Creek to Mill Creek Canyon is composed mainly of resistant quartzites with considerable slate. The soils in this vicinity have a lower lime content than those to the north, which are derived from the softer limestones, shales, and sandstones, although the relation is not so clear or marked as might be expected from the geology.

Much of the fine-textured material in the lake terraces, stream terraces, and bottom lands is very much mixed and generally is highly calcareous.

The soils on the well-drained alluvial fans and lake terraces generally have brownish-gray or pale-brown surface soils, which are weak brown, dusky brown, or dark brown when moist. Thus in the surface soils a great variety of parent rock color is generally masked by the presence of more or less humified organic matter, emphasizing the importance of the environmental factors. That soil-development processes have been active is also shown by the large extent of fairly mature soil profiles as exemplified by soils of the Bingham, Taylorsville, Welby, and Avon series. About 40 percent of the Salt Lake area has a soil profile approaching maturity.

The soils of the Taylorsville series probably represent the normal regional or zonal soil about as well as any soils of the area, although they have developed from fine-textured calcareous lake deposits and are probably somewhat too highly calcareous to represent exactly the normal zonal development. These soils lie on lake terraces that, in their natural condition, are well-drained. They are free from gravel and stone, and the soil profile is comparatively uniform over considerable areas.

A profile of Taylorsville silty clay loam was examined on a comparatively smooth old lake terrace where drainage is good. The soil had previously been cultivated, but at the time it was examined it was in pasture. Small grains, alfalfa, and sugar beets were growing nearby. A description of the profile follows.

0 to 10 inches, medium to light brownish-gray silty clay loam that breaks into rather soft, easily crumbled clods. Only very slightly calcareous.

10 to 21 inches, brownish-gray compact heavy silty clay loam or clay that breaks into rather hard clods. Distinctly calcareous.

21 to 34 inches, very light brownish-gray silty clay, seamed and streaked with white lime carbonate. Rather compact and platy.
34 to 48 inches, very light brownish-gray or very pale brown silty clay loam or silty clay. Prismatic or platy structure (planes of cleavage both horizontal and vertical), with hard, brittle aggregates. Highly calcareous.
48 to 72 inches, light olive-gray or yellowish-gray heavy silty clay loam or silty clay, forming hard, angular plates. Typical of the old lake clay deposits. Contains streaks and spots of rusty brown. Highly calcareous.

The Welby soils are similar to the Taylorsville soils in color and degree of profile development and in all other respects except the coarser and more open subsoil and substratum. They have developed from somewhat coarser deposits on the lake and stream terraces.

The Bingham soils are extensive zonal soils that in some ways represent the normal zonal development better than the Taylorsville soils. They generally occur at higher elevations than the Taylorsville soils and have developed on alluvial fans over porous beds of gravel and stone. Considerable variations are included in the series, but all the soils are characterized by surface soils that contain little or no lime, considerable fine soil material, and a moderate quantity of organic matter; subsoils that contain a high concentration of lime; and porous substrata of gravel, cobbles, and stones. The lime layer ranges from soft and loose to firmly cemented and hardpanlike.

Bingham gravelly loam was examined on an alluvial fan somewhat above the Provo level of old Lake Bonneville. This soil has never been irrigated but may have been cultivated for dry farming. Downy chess (cheatgrass) was the only plant growing at the place where the soil profile was examined. A poor, stunted growth of wheat was observed nearby, indicating a droughty condition. Samples of the various horizons were taken by digging well back into the bank in a deep gravel pit. Although the gravel below 3 feet is nearly free of fine soil material, except for carbonate of lime, there is sufficient cementation or coherence in the gravel to maintain a vertical exposure of 8 feet or more. A description of the soil profile follows.

0 to 7 inches, brownish-gray friable granular gravelly loam that is dusky brown when moist. Probably more than 50 percent of the total mass is gravel. The soil material is not calcareous.
7 to 13 inches, brownish-gray slightly compact gravelly loam, breaking readily into soft clods. Not calcareous.
13 to 24 inches, brownish-gray friable gravelly loam, containing 40 to 50 percent of gravel. The material is mottled with white lime carbonate, and practically all of the gravel is lime-coated. The fine material in this horizon is rather highly calcareous.
24 to 35 inches, light-gray lime-cemented gravel. The cementation is rather feeble.
35 to 42 inches, a loose porous gravel bed. The gravel has a slight coating of carbonate of lime.
42 to 72 inches, a bed of gravel somewhat finer than that above. Gravel is lime-coated. Drainage is excessive.

The native vegetation of the Bingham soils is dominantly sagebrush, accompanied by some bunchgrasses.

Some included areas of Bingham soils on the east side of the valley, southeast of Salt Lake City, have a slightly browner surface soil and a browner and heavier upper subsoil layer. The difference in color is probably due mostly to the color of the quartzite, limestone, and sandstone parent materials or parent rocks in this locality.

The Parleys soils are somewhat similar to the Taylorsville and Welby soils, but are somewhat darker and browner, have somewhat less accumulation of lime in the subsoil, and probably represent a somewhat less mature soil development. The difference in color is probably due to a slightly higher content of organic matter, due to higher rainfall and more luxuriant native vegetation and partly to the color of the parent materials, which are more local in origin and include material from quartzite, sandstone, limestone, shale, and slate.

The Wasatch soils probably should be considered intrazonal soils, as they are formed from very coarse porous materials from granite and quartzite, and they do not have the layer of lime accumulation that characterizes the zonal soils. They have a thin surface soil containing a fair amount of organic matter, a thin incipient subsoil layer containing a slight concentration of clay and colloids, and a substratum consisting of loose coarse sand and gravel practically free of fine soil material.

Intrazonal soils are extensive in the Salt Lake area, especially on the lake plain west of Salt Lake City and in the bottom lands along the Jordan River and some of its tributaries.

The soils of the lake plain are largely Solonchak and Solonetz. The Solonetz profile is developed best in the Terminal soils but is not uniform. In some places it occurs in scattered spots surrounded by Solonchak. A typical profile of Terminal silty clay loam, showing a fairly well-developed Solonetz morphology, was examined in the bank of an artificial drainage ditch on the lake plain west of Salt Lake City. A detailed description follows.

0 to 3 inches, light brownish-gray silt loam or silty clay loam. It has a fragile, thin, platy structure and is only slightly calcareous. According to the Wheatstone bridge, it contains 0.06 percent of soluble salts.

3 to 7 inches, rather compact light brownish-gray silty clay loam that breaks into moderately hard clods. Contains little or no lime and about 0.04 percent of soluble salts.

7 to 11 inches, medium-brown or coffee-brown columnar clay. The columns are about three-fourths to 1 inch in diameter, and the tops are somewhat rounded. They are not calcareous at the top but are distinctly so at the bottom. They are coated with comparatively dark, probably organic, colloidal coatings, and the material on the inside is light brownish gray. The material contains about 0.11 percent of soluble salts.

11 to 18 inches, mottled brown and white massive clay that is highly calcareous and contains about 0.19 percent of soluble salts..

18 to 24 inches, light-gray or yellowish-gray clay, somewhat cemented and marly, and contains a few thin plates of lime hardpan. Contains 0.53 percent of soluble salts.

24 to 40 inches, light yellowish-gray or light olive-gray heavy plastic clay containing a few rust-brown mottles. The content of soluble salts is 0.77 percent.

40 to 72 inches, pale-orange plastic clay containing about 1 percent of soluble salts. Water stands at a depth of 6 feet.

The Airport soils are similar to the Terminal soils but typically do not have a columnar claypan like that in the Terminal soils, nor do they have so high a concentration of lime in the subsoil. They are similar to the Taylorsville soils but are more poorly drained and contain higher concentrations of soluble salts.

The Saltair soils are clayey Solonchak with extremely high surface concentration of salts. In many places the land is barren of vegetation and the surface is crusted with salts. The soils have little definite

profile; in fact, they might be considered simply unaltered lake deposits, not soils.

The typical Decker soils are also Solonchak. They are developed from an overwash of sandy granitic materials over fine-textured calcareous lake deposits.

The Logan and Gooch soils are poorly drained soils of the bottom lands and flat areas on terraces—probably Wisenboden. They are highly calcareous throughout and generally contain considerable quantities of soluble salts. They apparently owe their outstanding characteristics to the fact that they have been saturated a large part of the time by lime-charged waters. The Logan soils are dark gray and contain considerable organic matter; the Gooch soils are light gray and contain medium to small quantities of organic matter. Those areas of Logan soils classified as alluvial-fan phases are somewhat better drained than the typical soils and contain comparatively small quantities of soluble salts.

The Churchill and Avon soils are intrazonal soils of a different kind from the others described. They are at present well-drained and free from harmful concentrations of soluble salts but apparently were once poorly drained. The Churchill soils are shallow soils over a hardpanlike layer of calcareous tufa or travertine; and porous beds of gravel underlie the tufa. The Avon soils have a thin surface soil over a more or less well-developed brown prismatic claypan. The lower part of the subsoil is calcareous and contains a rather high concentration of soluble salts. These soils are solonetzlike in character and may be solodized Solonetz.

The Red Rock, Draper, and Knutsen soils are azonal soils that consist of young deposits of alluvium that apparently have been very little altered since deposition, although they have some accumulation of organic matter in the surface soils. The Red Rock soils have a slight concentration of lime in the subsoils.

Preston fine sand and Oolitic sand are loose sandy soils without distinct layers and are definitely azonal.

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APPENDIX

KEY TO THE SOILS OF THE SALT LAKE AREA, UTAH

I. Well-Drained Soils of the Terraces and Alluvial Fans.
  - A. Mature (zonal) soils with distinct concentration of lime in the subsoils.
    - 1. Brownish-gray medium- to fine-textured soils with permeable subsoils. Medium to fine stratified alluvial and lake-laid materials.
      - Welby loam.
      - Welby loam, sloping phase.
      - Welby loam, hardpan phase.
      - Welby fine sandy loam.
      - Welby fine sandy loam, sloping phase.
      - Welby silty clay loam.
    - 2. Brownish-gray medium- to light-textured soils over heavy relatively tight subsoils. Dominantly of fine lake-laid materials, but with some medium and coarse alluvial and wind-laid materials.
      - Taylorsville loam.
      - Taylorsville loamy fine sand.
      - Parleys loam.
      - Parleys loam, gravelly phase.
      - Decker loam, well-drained phase.
      - Avon gravelly loam.
    - 3. Brownish-gray heavy soils over heavy relatively tight subsoils. Fine lake-laid materials.
      - Taylorsville silty clay loam.
      - Taylorsville silty clay loam, hardpan phase.
      - Taylorsville silty clay loam, shallow phase (over Bingham soil material).
      - Parleys silty clay loam.
  - B. Immature (azonal) soils with little or no distinct concentration of lime in the subsoils.
    - 1. Brown to brownish-gray medium- to fine-textured soils from mixed alluvial materials. Subsoils generally contain some lime.
      - Red Rock loam.
      - Red Rock clay loam.
      - Red Rock silty clay loam.
      - Red Rock fine sandy loam.
      - Red Rock gravelly loam.
      - St. Marys loam.
    - 2. Dark brownish-gray medium- to coarse-textured soils from granitic alluvial materials. Subsoils generally contain little or no lime.
      - Draper loam.
      - Draper coarse sandy loam.

II. Well-Drained and Excessively Drained Soils of the Higher Alluvial Fans.
  - A. Mature (zonal) soils with limy subsoils over beds of mixed gravel.
    - 1. Brownish-gray and grayish-brown gravelly soils with open subsoils.
      - Bingham gravelly loam.
      - Bingham gravelly loam, deep phase.
      - Bingham gravelly loam, steep phase.
      - Bingham very gravelly loam.
      - Bingham gravelly fine sandy loam.
    - 2. Brownish-gray and grayish-brown soils containing little gravel, with open subsoils.
      - Bingham loam.
      - Bingham loam, deep phase.
      - Bingham coarse sandy loam.
      - Bingham fine sandy loam.

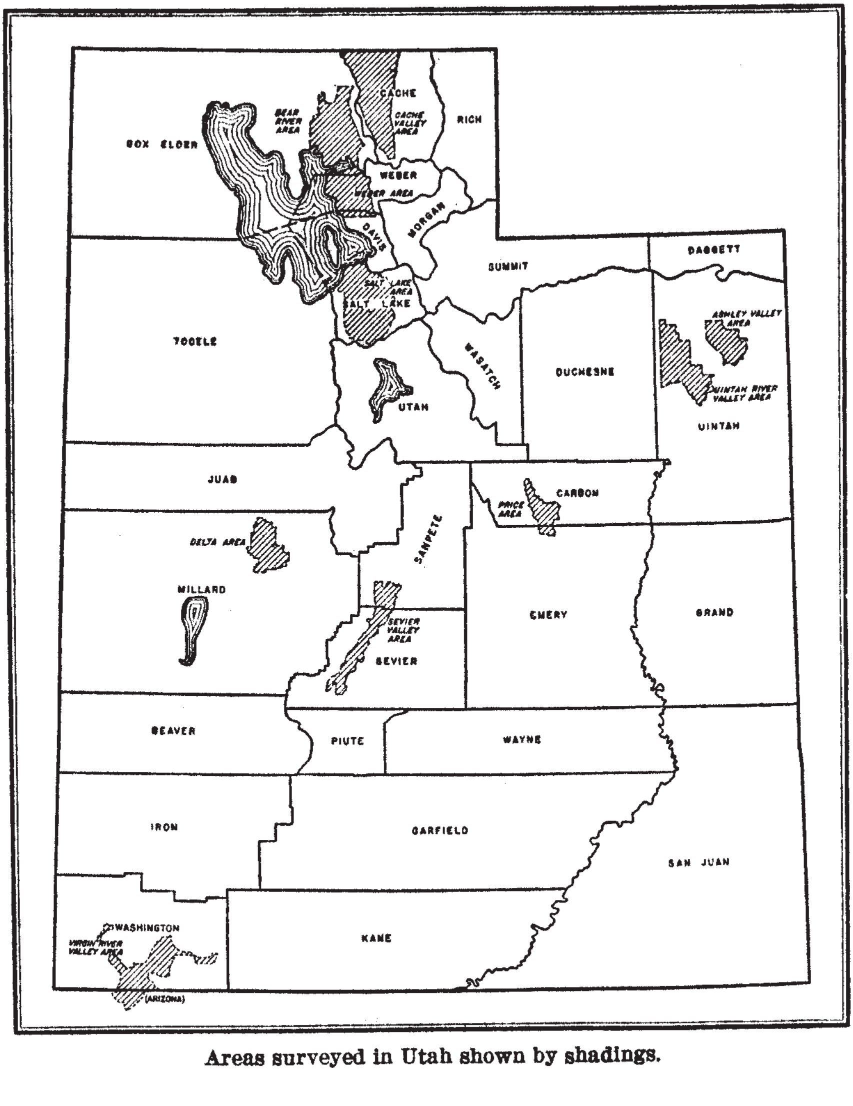
II. Well-drained and Excessively Drained Soils of the Higher Alluvial Fans.—Con.
- A. Mature (zonal) soils with limy subsoils over beds of mixed gravel.—Con.
  - 3. Brownish-gray soils with a layer of calcareous tufa over gravel.
    - Churchill loam.
- B. Immature (azonal) soils with little or no lime in subsoils, over beds of mixed gravel.
  - 1. Medium to dark brownish-gray soils.
    - Knutsen gravelly loam.
    - Knutsen loam.
- C. Immature (intrazonal) sandy soils with little or no lime in subsoils, over granitic sand and gravel.
  - 1. Brown to grayish-brown soils containing much coarse granitic grit.
    - Wasatch coarse sandy loam.
    - Wasatch sand.
    - Wasatch loamy sand.
    - Wasatch loam.
    - Wasatch gravelly coarse sandy loam.
    - Wasatch sandy loam, shallow phase (over Welby soil material).

III. Imperfectly and Poorly Drained Soils of the Bottom Lands, Terraces, and Alluvial Fans.
- A. Mature (zonal) soils with distinct concentration of lime in the subsoils. (Poor drainage induced by irrigation and seepage.)
  - 1. Brownish-gray medium- to fine-textured soils from mixed alluvial and lake-laid deposits.
    - Welby loam, poorly drained phase.
    - Welby fine sandy loam, poorly drained phase.
    - Taylorsville silty clay loam, poorly drained phase.
    - Taylorsville silty clay, loam, overwash phase.
- B. Immature (azonal and intrazonal) soils with little or no lime concentration in the subsoils. (Poor drainage induced by irrigation.)
  - 1. Brown to brownish-gray medium- to fine-textured soils from mixed alluvial materials.
    - Red Rock fine sandy loam, poorly drained phase.
    - Red Rock silty clay loam, poorly drained phase.
  - 2. Brown to grayish-brown sandy soils over granitic sand and gravel.
    - Wasatch coarse sandy loam, poorly drained phase.
    - Wasatch sandy loam, shallow poorly drained phase (over Welby soil material).
  - 3. Medium to dark grayish-brown soils over mixed gravel.
    - Knutsen loam, poorly drained phase.
- C. Immature (intrazonal) soils with much lime in the subsoils. (Poor drainage natural or induced by irrigation.)
  - 1. Brown to dark brownish-gray medium- to coarse-textured soils from granitic materials over light-gray limy subsoils from mixed materials.
    - Decker loam.
    - Decker sandy loam.
    - Draper loam, poorly drained phase.
    - Draper loam, shallow phase (over Taylorsville soil material).
  - 2. Dark-gray soils over light-gray limy subsoils.
    - Logan clay.
    - Logan silty clay loam.
    - Logan loam.
    - Logan silty clay loam, alluvial-fan phase.
    - Logan loam, alluvial-fan phase.
  - 3. Light-gray soils very limy throughout.
    - Gooch clay loam.
    - Gooch loam.

IV. Poorly Drained Salty Soils of the Lake Plain.
- A. Intrazonal soils.
  - 1. Light brownish-gray medium-textured soils with heavy limy subsoil.
    - Airport loam.
    - Airport loam, deep phase.

IV. Poorly Drained Salty Soils of the Lake Plain—Continued
  A. Intrazonal soils—Continued
    2. Light brownish-gray medium- to fine-textured soils with claypan and lime hardpan (Solonetz).
      Terminal loam.
      Terminal silty clay loam.
    3. Light- to dark-gray wet clay soils without distinct profile.
      Saltair clay.
      Saltair clay, mucky phase.

V. Miscellaneous Soils and Land Types, Largely Nonarable.
    1. Stony soils.
      Bingham stony loam.
      Wasatch stony loam.
    2. Loose wind-blown sand.
      Preston fine sand.
      Oolitic sand.
    3. Rough broken land.
      Rough broken and stony land.
      Rough broken land (Bingham soil material).
      Rough broken land (Wasatch soil material).
      Rough broken land (Welby and Taylorsville soil materials).
    4. Miscellaneous.
      Unclassified city land.
      Pits and dumps.
      Riverwash.



Areas surveyed in Utah shown by shadings.

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SALT LAKE AREA
UTAH

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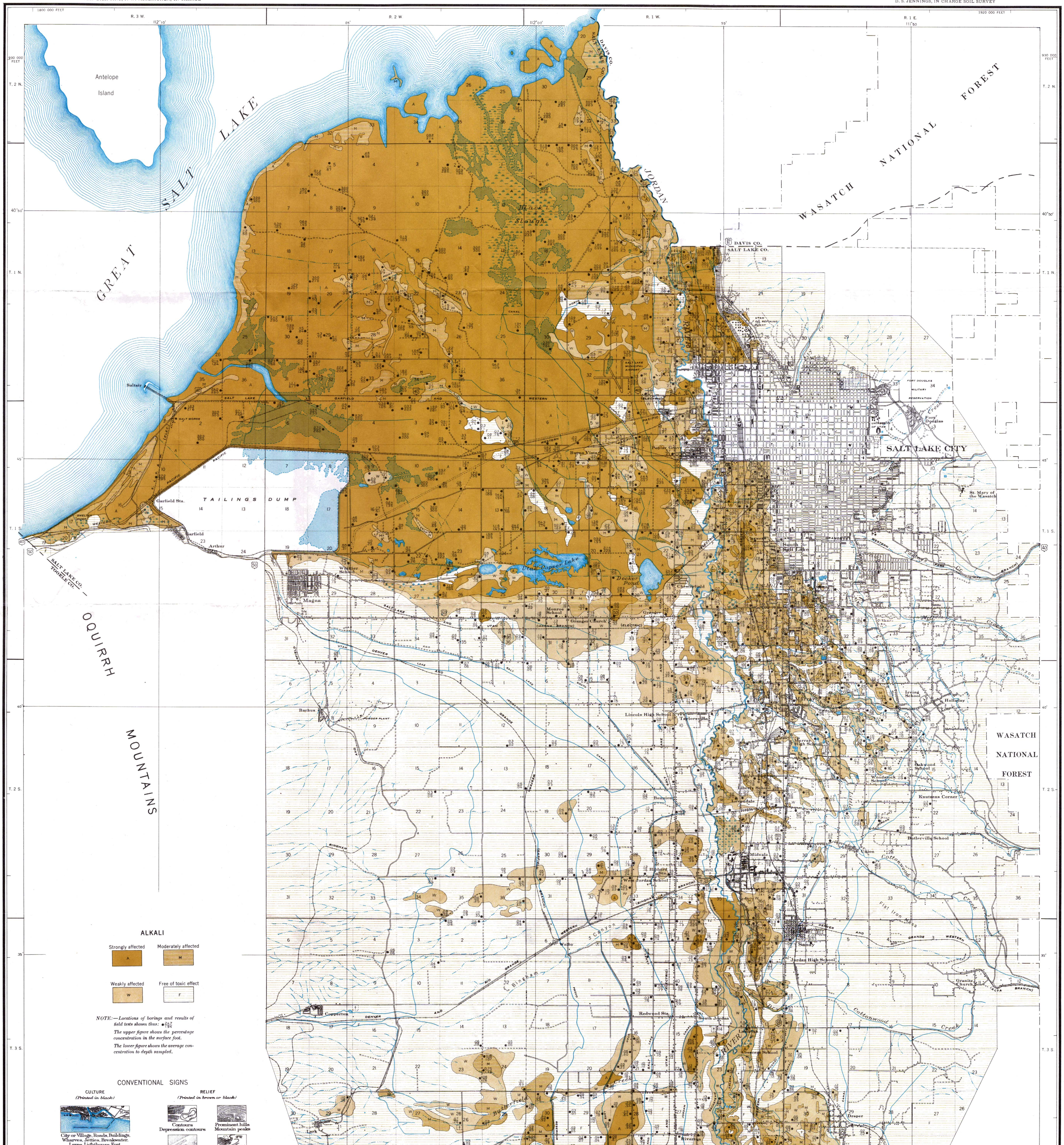

Macy H. Lapham, Senior Soil Scientist.
Soils surveyed by D. S. Jennings, in charge, and J. E. Fletcher, M. H. Wallace, LeMoyne Wilson, and I. D. Zobell, Utah Agricultural Experiment Station, and F. O. Youngs and O. F. Bartholomew U. S. Department of Agriculture.

Scale 1 inch-1 mile

Polyconic projection, North American Datum.
Horizontal control by U. S. G. S. and U. S. C. and G. S.
Base map in part from U. S. Geological Survey Sheets.
10000 foot grid based upon Utah (Central) system of plane coordinates.
Surveyed in 1934-36. Series 1936.

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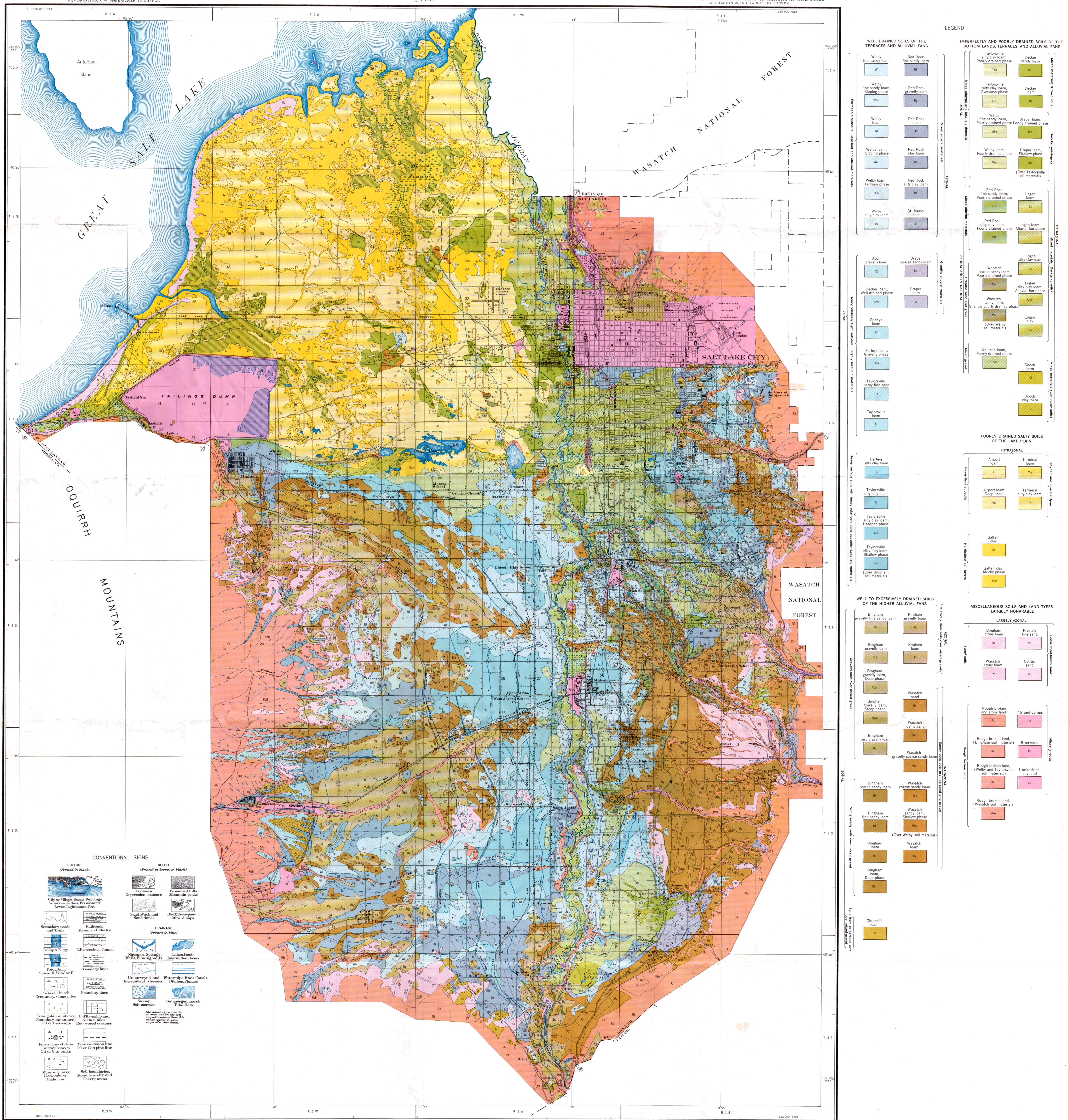

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